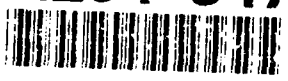
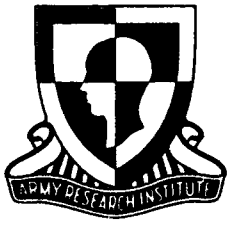


Technical Report 950

Combat Vehicle Command and Control Systems: I. Simulation-Based Company-Level Evaluation

Bruce C. Leibrecht, James W. Kerins, Frances M. Ainslie, Alicia R. Sawyer, Jerry M. Childs, and William J. Doherty
BDM International, Inc.

April 1992



United States Army Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

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13. ABSTRACT *(Maximum 200 words)*

This research evaluated the training implications, including operational effectiveness and soldier-machine interface (SMI), of a Combat Vehicle Command and Control (CVCC) experimental configuration that included the Commander's Independent Thermal Viewer and a Command and Control display. Using M1 tank simulators in the Close Combat Test Bed at Fort Knox, KY, the evaluation focused on tank company operations. Each of nine groups of soldiers completed a 1-week training and testing schedule that culminated in two simulated combat scenarios. One of a series, this report documents significant improvements in crew/unit performance attributable to the CVCC configuration. Companion reports address training-related findings, SMI recommendations, and performance from a tactical perspective. The collective findings provide input to the design and development of training programs for future automated command, control, and communications systems in ground combat vehicles.

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FOREWORD

The Fort Knox Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) conducts soldier-in-the-loop research addressing training requirements for the future integrated battlefield. These efforts are supported by Memoranda of Understanding (MOU) with (a) the U.S. Army Armor Center and Fort Knox, Subject: Research in Future Battlefield Conditions, dated 12 April 1989; and (b) the U.S. Army Tank-Automotive Command (TACOM), Subject: Combat Vehicle Command and Control (CVCC) Program, dated 22 March 1989.

One of a series of reports resulting from a company-level, simulation-based evaluation of a CVCC experimental configuration, this report comprehensively documents performance results. Other reports in the series address training implications, soldier-machine interface issues, and performance from a tactical perspective.

The CVCC experimental configuration provides an excellent test bed for investigating training requirements of future automated command, control, and communications (C^3) technology for armored vehicles. Its capabilities include a Commander's Independent Thermal Viewer (CITV), a computerized tactical map, positioning and navigation functions, and digital preparation and transmission of reports and overlays. The research was conducted using the simulation capabilities of the Close Combat Test Bed at Fort Knox, Kentucky. The findings should assist the Army in designing and developing training programs for automated C^3 systems in ground combat vehicles. The information will support training developers, as well as combat and materiel developers.

Information resulting from this research has been briefed to the Directorate of Combat Developments, U.S. Army Armor School and the Director, Vetronics Division, TACOM Research, Development and Engineering Center.

EDGAR M. JOHNSON
Technical Director

ACKNOWLEDGMENTS

Several members of the U.S. Army Research Institute for the Behavioral and Social Sciences Fort Knox Field Unit played key roles in this evaluation: Barbara Black, leader of the Future Battlefield Conditions (FBC) team; Kathleen Quinkert and Carl Lickteig, FBC team members; and Major Milton Koger, the Field Unit's research and development coordinator.

In addition to the authors, the BDM International, Inc. research staff included Nancy Atwood, Mary Campbell, and Karen Lameier. Research assistants supporting the project were Valerie Barham, Maureen Barthen, David Behringer, Michelle Cole, Sandra Hall, Terri Hall, Jane Hurtgen, Charles Meier II, Owen Pitney, Rosemary Terry, Michael Vanderkarr, and Timothy Voss.

Technical support of simulation equipment and data collection/analysis was provided by personnel of the on-site support contractor, Bolt Beranek and Newman, Inc.--most notably, Rex Downey, Diane York, Paul Monday, and George Bradford.

The evaluation resulted in a large, multifaceted set of data. To present the findings, a family of four reports has been organized, each focusing on a different aspect of the data. Since the data all derived from a single evaluation effort, they share the same background and methodology. Consequently, the authors of all four reports have relied on common narrative where appropriate. This approach served to ensure clarity and consistency across the separate reports. The occasional use of uniform text is limited to the background, design, and method sections of the reports. The commonalities reflect the full knowledge and agreement of all authors.

COMBAT VEHICLE COMMAND AND CONTROL SYSTEMS: I. SIMULATION-BASED COMPANY-LEVEL EVALUATION

EXECUTIVE SUMMARY

Requirement:

To support automated command, control, and communications (C^3) on the future battlefield, the U.S. Army is conducting the Combat Vehicle Command and Control (CVCC) research and development program. A major program thrust uses soldier-in-the-loop methodology to evaluate future C^3 capabilities. Previous research used tank crews and platoons to evaluate proposed new capabilities individually. A company-level evaluation of the integrated capabilities is an important follow-on step.

Procedure:

Tank simulators located in the Close Combat Test Bed at Fort Knox, Kentucky, were used to support both CVCC and baseline test conditions. The CVCC condition included the Commander's Independent Thermal Viewer (CITV) and a Command and Control Display (CCD); the latter incorporated the Position Navigation (POSNAV) system, a real-time tactical map display, and digital report and overlay capabilities. Basic tank simulators without the CITV or CCD defined the baseline condition. Nine groups of active duty soldiers (five CVCC, four M1 baseline) each completed 1 week of training and testing culminating in 2 half-day simulated combat test scenarios.

Findings:

Automated and manual data revealed significant improvements in mission/tactical performance and C^3 performance attributable to the integrated CVCC configuration. CVCC-equipped companies completed the defensive and offensive scenarios in less time, traveled less distance, and consumed less fuel. Accuracy and timeliness of fragmentary orders (FRAGOs) and CONTACT reports, along with clarity of FRAGOs and INTELLIGENCE reports, improved in the CVCC condition. The CVCC capabilities enhanced target engagement performance, extending maximum lasing range as well

as target hit and kill ranges. During the defensive scenario, CVCC units conducted a more timely displacement. The CCD-related C^3 demands on CVCC leaders (Company Commanders and Platoon Leaders) did not decrease firing activities.

Utilization of Findings:

The results of this research provide important input to the design and development of training programs for future automated C^3 systems in ground combat vehicles. The findings will also be of use to combat and materiel developers, as well as modelers, other researchers, and unit commanders.

COMBAT VEHICLE COMMAND AND CONTROL SYSTEMS: I. SIMULATION-BASED COMPANY-LEVEL EVALUATION

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COMBAT VEHICLE COMMAND AND CONTROL SYSTEMS: I. SIMULATION-BASED COMPANY-LEVEL EVALUATION

Introduction

Human performance and training implications associated with the future battlefield are receiving increased emphasis within the armor research and development community. The advantage to be gained over the adversary in future conflicts lies not in equipment and technology per se, but in the optimized use of that technology by battlefield commanders and soldiers. This contention is supported by data indicating that current weapon systems possess greater capabilities than are being exploited by Army crews (Beecher, 1989).

The research described in this report was conducted as part of the Combat Vehicle Command and Control (CVCC) Program, a U.S.-German bilateral research and development effort focusing on automated command, control, and communications (C^3). Designed to refine requirements and specifications for automated C^3 systems in ground combat vehicles, the program is sponsored by the U.S. Army Tank-Automotive Command (TACOM) and is supported in part by Balanced Technology Initiative funds. The project reported here represented a major step in multifaceted efforts managed by the Soldier-Machine-Interface and Simulation (SMI&S) Team, one of four bilateral teams configured to plan and implement the parent program. The efforts and products of the four teams are interrelated. For example, recommendations of the SMI&S Team regarding display formats could impact the activities of the Vehicle Integration Team, the User Requirements Team, or the Communications Team.

The company level evaluation was an extension of a series of simulation-based CVCC research studies conducted by the Future Battlefield Conditions Team of the U.S. Army Research Institute's (ARI) Fort Knox Field Unit, which heads the SMI&S Team. The goal of the research was to demonstrate the synergistic outcome of integrating CVCC conceptual systems to enhance ground combat C^3 and to extend the performance database to support future CVCC design improvements. Specific objectives were to (a) investigate training implications, (b) evaluate operational effectiveness, and (c) identify key soldier-machine-interface issues.

One of a family of four ARI technical and research reports resulting from the evaluation, this report addresses soldier performance dimensions based principally on objective data. Companion reports deal with training issues (Atwood, Quinkert, Campbell, Lameier, Leibrecht, & Doherty, 1991), soldier-machine interface concerns and recommendations (Ainslie, Leibrecht, & Atwood, 1991), and tactical aspects of performance (Kerins & Leibrecht, in preparation).

Background and Review of Key Literature

Future battlefield plans call for Army command and control, communications, intelligence, and electronic warfare to be effectively integrated into the Battlefield Information System. The overall strategy for achieving this integration is outlined in the Army's Technology Base Master Plan (Department of the Army, 1989a). The strategy includes distributed C^3 capabilities, battlefield synchronization, increased decision aiding, force level interoperability, and improved analysis tools.

As the Army moves to prepare for the twenty-first century, there is a growing recognition of the importance of achieving maximum synergy between technological innovation and personnel capabilities to employ the new technology. Increasingly, human performance is viewed as a fundamental and pivotal consideration in the design and implementation of Army weapon systems. The Army's Life Cycle System Management process calls for earlier and more continuous attention to soldier capabilities and limitations during the developmental cycle (Department of the Army, 1988a).

Moreover, national defense policy actions demand the use of effective combat simulations to address human performance issues very early in the systems procurement cycle. The cost effectiveness and other benefits of the judicious use of these simulations have been well documented (e.g., Kraemer & Bessemer, 1987; Quinkert & Black, 1987).

The Close Combat Test Bed

One of the foremost tools for conducting low-cost armor C^3 combat simulations is the Close Combat Test Bed (CCTB)[1]. The CCTB employs selective fidelity networked simulation at Fort Knox, Kentucky. As human performance research initiatives have evolved in conjunction with evaluations of new technology, the CCTB has been used increasingly as a soldier-in-the-loop research facility. It is designed to realize low-cost, unit-level, full mission simulation using extended local and long-haul networking and families of simulators supported by site-specific microprocessors (Du Bois & Smith, 1989; Miller & Chung, 1987).

The CCTB represents distributed networking architecture that can be modified to accommodate a broad range of soldier performance R&D. One of the features of this architecture is the employment of selective physical and functional fidelity to achieve acceptable levels of C^3 system realism. Selective fidelity enables system performance to be sufficiently emulated to elicit the required levels of perceptual realism among users

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[1]The CCTB was formerly known as the Simulation Network - Developmental (SIMNET-D) facility. The term CCTB will be used throughout this document to refer to the facility. However, the term SIMNET will be used to refer to the technology of distributed simulation networking.

(Chung, Dickens, O'Toole, & Chiang, 1988). This "psychological fidelity" enables the battlefield-oriented perceptual cues within the test bed to be utilized without having to employ more expensive operational technology. The CCTB allows the Army to simulate and assess combat capabilities using C^3 experimental configurations prior to system design and development.

CCTB Capabilities

Du Bois and Smith (1989) have thoroughly described the research capabilities of the CCTB. Central to the test bed are the manned vehicle simulators, which model actual vehicles to the minimum degree necessary for soldiers to accept them as realistic and useful (Chung et al., 1988). Simulation components reproduce key sound and visual aspects of the battlefield operating environment. Integral to the CCTB are semiautomated forces (SAFOR), both friendly and enemy. These consist of computer-generated vehicles under the control of a human operator who can interact as a role-player with leaders in the manned simulators, as appropriate. A variety of computer-based systems provides tactical communications, scenario control and monitoring capabilities, and robust data collection and analysis support. Table 1 summarizes these capabilities and Figure 1 shows a schematic of the basic system architecture.

CCTB Advantages

Armor crew and unit performance-oriented research carried out within the test bed in recent years has produced data of substantial operational significance. This is directly related to the advantages inherent in the CCTB, including its

1. Cost effectiveness in evaluating experimental configurations of C^3 and related systems.

2. Value in identifying training requirements.

3. Capability to present tank crews and units with operationally realistic task and mission loading levels.

4. Flexibility in allowing crews to perform a broad range of missions.

5. Versatility in providing realistic engagement interaction in a variety of simulated battlefield settings.

6. Tactical communications fidelity.

7. Automated capability to capture and analyze objective performance data.

8. Unique analysis capabilities afforded by playback.

Table 1

Basic Capabilities of the CCTB

Capability	System implementation
Manned simulators	Selective fidelity crewstations, with supporting hardware and software.
Tactical communications	Simulated Single Channel Ground and Airborne Radio System (SINCGARS) for linking manned simulators and control stations; capable of both voice and digital burst transmission.
Surrogate vehicles	Semiautomated forces program for creating and controlling unmanned vehicles and aircraft, both friendly and enemy; provides digital message traffic.
Scenario control	Management, Command and Control system for controlling and monitoring manned simulators and implementing fire support. SEND station for transmitting digital messages.
Scenario monitoring	Plan View Display monitors providing a "bird's eye view" of a simulation exercise; supports map manipulation and event flagging. Stand-alone Command and Control Display to monitor digital message traffic.
Data recording and analysis	Data Collection and Analysis system for on-line recording of automated data and off-line reduction and analysis; supports playback. LISTEN station to record digital messages.

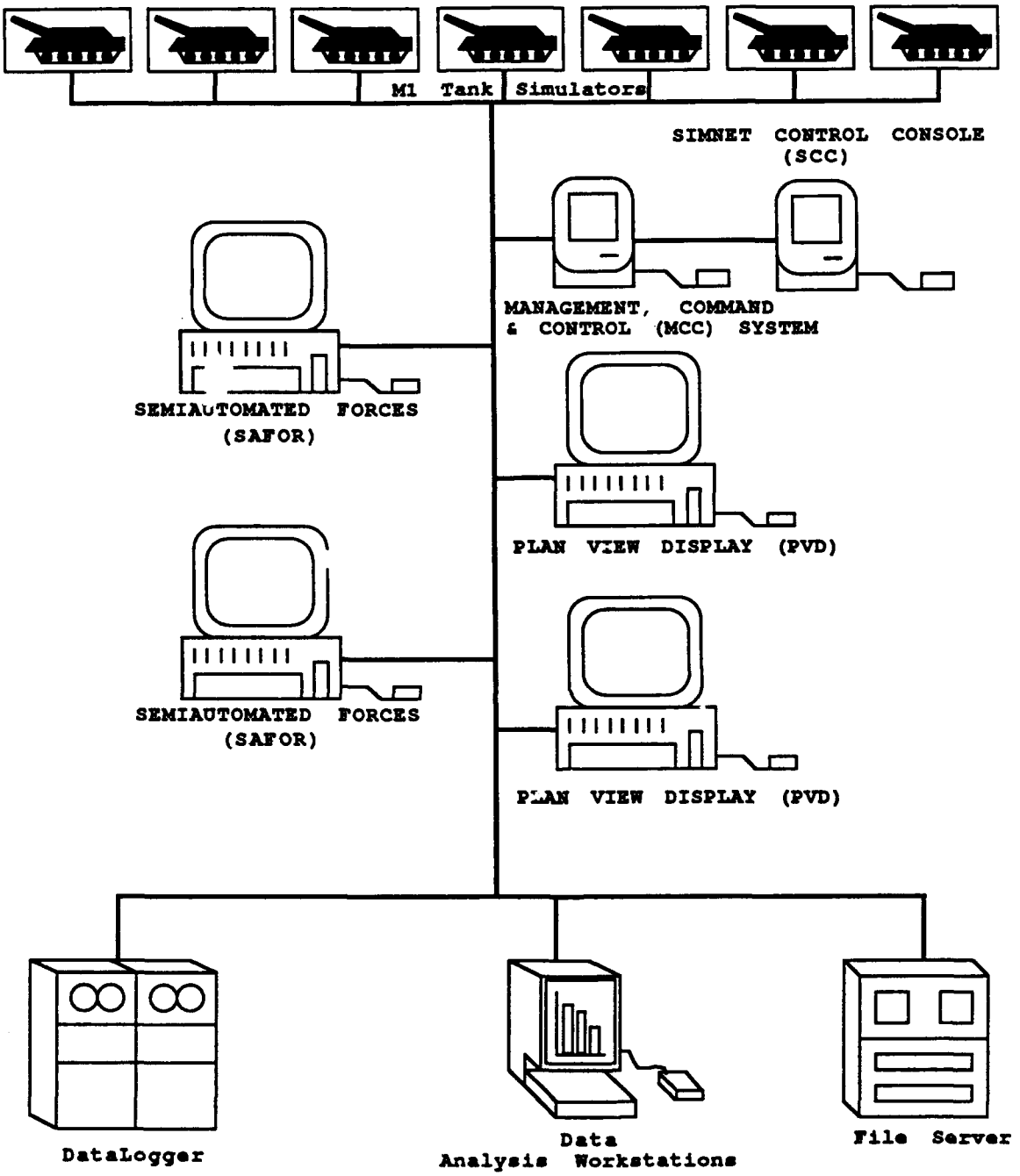

Figure 1. Schematic of the basic distributed simulation networking architecture. (M1 tank simulators represent the battlefield environment. Computer terminal style workstations correspond to exercise control systems. The components along the bottom depict data collection and analysis capabilities.)

CCTB Constraints

As with any large-scale simulation, the CCTB possesses several constraints with respect to its representation of operational armor settings. These limitations have been described in detail by Du Bois and Smith (1989). Briefly they are:

1. Inability to conduct open hatch operations, which limits the tank commander's view of the battlefield.

2. Limited visual fidelity of the computer-generated imagery, which limits depth perception, battlefield orientation, long-range target identification, and certain tactical maneuvers.

3. Maximum simulated viewing distance of 3500 meters, resulting in a potentially distorted horizon.

4. Lack of vehicle identification plates, resulting in problematic identification of friendly vehicles.

5. Lack of a gunner's auxiliary sight.

Several special features help offset the above constraints. For example, a grid azimuth indicator and a turret reference display help compensate for the closed hatch constraint, providing cues that are critical for positioning, maneuvering, and navigation. To counter the limited visual fidelity, special topographic paper maps represent buildings, rivers, roads, etc. as they appear on the simulated battlefield. And special tactical guidelines have been developed to mitigate the limited viewing distance.

ARI-Fort Knox Future Battlefield Conditions Research Program

The ARI-Fort Knox Future Battlefield Conditions Team has pioneered and sustained the application of the CCTB to evaluate emerging concepts related to armor system design and development. For example, the test bed has supported soldier-in-the-loop assessments of several communication and navigation concepts that offer significant potential improvements in overall battlefield performance. These combat performance increments accrue as a result of identifying and incorporating human performance capabilities and limitations during the early stages of development.

In a ground-breaking study, Du Bois and Smith (1989) empirically evaluated an automated Position Navigation (POSNAV) system configured in either grid (POSNAV-G) or terrain (POSNAV-T) map format. The performance of armor crews using these formats was compared with that of crews using conventional navigational techniques. POSNAV capabilities enabled crews to navigate more accurately and efficiently than by conventional means in virtually all battlefield situations. For example, both POSNAV

groups performed road marches significantly better than the control group.

Relative to the control group, POSNAV crews were better able to determine own-tank location, maintain own-tank orientation, determine locations of other battlefield elements, perform map terrain association, navigate point to point, bypass obstacles, and react to enemy fire. Differences between POSNAV and control conditions in their questionnaire responses were statistically significant for 26 of the 30 measures analyzed. The research clearly suggests that POSNAV systems can be expected to significantly improve the performance of tank crews and platoons on the battlefield.

A related research effort (Quinkert, 1990) examined the performance enhancement capabilities of the Commander's Independent Thermal Viewer (CITV), a surveillance and target acquisition system for use in future main battle tanks (MBTs). The vehicle commander can employ the CITV to independently search a sector, identify and hand off targets to the gunner, and continue the search. The increase in "hunter-killer" efficiency afforded by the CITV is significant as measured by time to detect and engage multiple threat targets.

Results of the CITV assessment (Quinkert, 1990) indicated that the principal advantage in the use of the CITV is for those targets that are acquired and engaged after the initial target. This advantage was represented by an increase in the number of detections and subsequent kills accomplished at a significantly faster pace. Accuracy, as defined by gunners' aiming error, was not improved by use of the CITV. Gunners did not feel it necessary to take more time to engage the targets, even though the shorter vehicle commander search times nominally gave them more time. This reflected their high level of confidence in their gunnery skills.

Recommended improvements to the CITV included a directional orientation capability for the own-vehicle icon, shorter fire control commands, and ergonomic enhancements in the palm and designate switches on the control handle. It was also suggested that emphasis should be placed on training to improve the coordination between the vehicle commander and gunner regarding CITV use.

In a parallel effort, Du Bois and Smith (1990) evaluated an automated C^3 display termed the Intervehicular Information System (IVIS) using the CCTB. IVIS is a distributed information management system designed to provide improved capabilities to assess both friendly and threat battlefield situations.

Findings of the IVIS study indicated that tank crews and platoons equipped with IVIS performed significantly better than conventionally equipped control crews and platoons in virtually every capacity. Specifically, IVIS significantly improved unit performance in mission execution time and success, report times

and accuracy, fragmentary order execution, battle position occupation, and obstacle bypass efficiency. IVIS crews not only performed better overall than control crews, but perhaps more importantly, they also performed more consistently as indicated by smaller standard deviations for all measures. Significant differences in favor of IVIS-equipped crews were also found for a number of process measures including fuel use and mean velocity. The benefits of IVIS were attributed almost solely to the system's POSNAV capabilities, as opposed to the automated report functions. This may have resulted, at least in part, because the complexity of C^3 at the platoon level was insufficient to fully reveal the advantage of the automated C^3 equipment. This underscores the importance of extending the research to the company and battalion levels.

Applied behavioral research conducted and monitored by ARI within the CCTB has focused on the tactical performance of crews and platoons using advanced armor-based experimental configurations. Soldier-machine interface (SMI) issues and training implications have been addressed as well. Whereas three distinct systems (POSNAV, IVIS, and CITV) have been evaluated, no research has assessed operational performance enhancements, SMI issues, and training requirements associated with the integration of the three conceptual systems within the CCTB. Further, the performance database has not been extended above the platoon level. The present study was conducted to meet these needs.

Design of the Evaluation

Questions of Interest

Previous CVCC research projects have evaluated automated C^3 tools at the crew and platoon levels, assessing conceptual systems individually. As systems integration proceeds through repeated cycles of testing and redesign, the research will eventually extend to the battalion level with battalion Tactical Operations Center (TOC) elements interacting with manned and SAFOR company elements. To support larger unit simulations and future design improvements, realistic research must answer key questions. How do the integrated tools impact company level performance? How will the new tools affect requirements for training armor crews and units? What improvements are necessary to optimize utilization by platoon leaders and company commanders?

These questions led to the company level evaluation, the results of which will help guide training and design decisions and concepts for utilizing automated C^3 systems in the armor environment. An important parallel outcome is the new methods, materials, and analytical procedures developed in conducting the evaluation. These research tools will form the foundation for extending the effort to the battalion level.

Research Issues

Based on the primary questions of interest, planning and implementation of this evaluation incorporated three overall objectives:

1. Evaluate the operational effectiveness of armor companies using the integrated CVCC experimental configuration (henceforth referred to as the CVCC).

2. Determine operational training requirements, issues, and concerns for the CVCC.

3. Identify critical SMI issues associated with the use of the CVCC and make recommendations concerning redesign.

Each of these objectives encompassed its own set of research issues. The separate reports addressing the training and SMI objectives list the issues pertaining to those two objectives. In the context of simulated combat missions, the operational effectiveness issues were as follows:

1. What is the impact of the CVCC on overall mission performance?

2. How does the CVCC impact the acquisition and communication of information?

3. What is the effect of the CVCC on tactical situation assessments by vehicle commanders?

4. What impact does the CVCC have on commanders' effectiveness in directing and leading subordinate forces?

5. What is the effect of the CVCC on platoon and company movement?

6. How does the CVCC affect engagement of enemy forces?

General Approach

The general research approach was to compare the CVCC with an M1 Baseline condition, using soldiers in the loop. The methodology combined CCTB M1 tank simulators, both manned (auto-loading) and SAFOR, doctrinally based combat scenarios, and multimedia data collection techniques. The CVCC condition included the CITV with independent laser plus a Command and Control Display (CCD) with full color tactical map, POSNAV with waypoint autoadvance, digital report preparation, digital burst report transmission, and touchscreen control capability. Simulated combat scenarios provided opportunities for exercising the automated C^3 functions available and for judging their impact on tactical performance. To optimize scenario consistency, manned simulators were not permitted to be killed. Multiple phases (missions) within each scenario enabled repeated observations of performance.

Three different Fort Knox units furnished armor soldiers as dedicated participants forming "company slices," which were supplemented with SAFOR vehicles to form a full tank company. Replicating all the echelons of command normally present within an operational company, each company slice consisted of seven three-man crews (vehicle commander, gunner, driver): Company Commander (Co Cdr), one fully manned platoon--Platoon Leader (Plt Ldr), Platoon Sergeant (Plt Sgt), and two wingmen--and Plt Ldrs for the other two platoons. In order to minimize the effects of unit cohesion, a reconstituted company was modelled; no crew was allowed to include members who normally worked in the same crew. Training incorporated classroom, supervised hands-on, crew practice, and unit practice stages.

SAFOR vehicles/units comprised the entire enemy force in each scenario. The research staff, which included a command and control (C^2) subject matter expert, performed control functions for both friendly and enemy SAFOR elements. They also role-played key friendly battalion staff positions as well as vehicle commanders for the SAFOR elements of the manned company.

Data collection techniques capitalized extensively on automated recording capabilities but also relied heavily on manual instruments. Among the latter were questionnaires, observation logs, end-of-phase map plot exercises, and post-scenario debriefings. Measurement requirements spanned tactical

performance (mission accomplishment, assessment and planning, positioning and navigation, target acquisition and engagement), acquisition and communication of information, tactical control of the unit, training effectiveness, equipment usage, and recommendations for system improvement.

Research Design

The original design of the evaluation called for comparison of two automated C^3 configurations in order to support determination of soldier performance requirements and operational effectiveness estimates. The two configurations represented different levels of automated C^3 functionality. The configuration known as the Intra-Vehicular Command and Control (IVCC) system did not support digital transmission of information because it did not include a radio interface unit, which would be required to digitally burst information from vehicle to vehicle. Near the mid-point of the data collection for this evaluation, the Army reached a decision that the radio interface unit was a supportable requirement. This decision greatly limited the applicability of the IVCC data and, therefore, the condition was eliminated from the design.

The final design of the evaluation revolved around two primary independent variables: condition and scenario phase. Two conditions--the CVCC and M1 Baseline--formed a between-subjects variable with two levels. Defining each scenario were three phases consisting of separate combat missions sharing a common type of combat operation and a unifying overall scenario structure. These phases formed a three-level repeated measures variable.

A secondary independent variable resulted from the three echelons of manned positions within the company's organizational structure: Co Cdr, Plt Ldrs, and Tank Commanders (TCs--Plt Sgt and wingmen). This structure yielded a between-subjects variable with three levels, the number of subjects varying across echelons according to the ratio 1:3:3.

Two separate test scenarios--one offensive, one defensive--served to assess the operational utility of the CVCC equipment across different types of combat operations. In order to fit all training and testing activities into a schedule not exceeding five days, each test scenario was limited to a half day in duration. All participants performed in both scenarios. Disparate performance requirements resulted from the decidedly different character of the offensive and defensive scenarios (largely static vs. largely moving, widely different numbers of enemy vehicles, etc.). This made the two scenarios unsuitable for direct comparison.

The broad scope of the evaluation required a wide variety of dependent variables to quantify performance and equipment usage comprehensively. The types of measures appear in Table 2.

Table 2

Types of Measures, with Associated Measurement Processes

Type	Measurement Process
Tactical performance	Automated, Observational, Self-report
Tactical communication	Automated, Observational, Self-report
Information acquisition	Automated, Observational
Unit coordination & control	Automated, Observational
Equipment usage	Automated, Observational, Self-report
Soldier-machine interface	Self-report
Biographical factors	Self-report
Training effectiveness	Self-report

Method

This section details the resources and methods involved in conducting the evaluation. Described first are the personnel who supported the evaluation, both as participants and as research team members. Equipment, materials, and facilities used are presented next. The final subsection describes procedures used for training participants, implementing test scenarios, and collecting and analyzing data.

Subjects and Key Personnel

A total of 189 U.S. Army personnel--36 commissioned officers, 51 noncommissioned officers (NCOs), and 102 enlisted men--served as participants in the data collection phase, which lasted 9 weeks. These participants were scheduled in groups of 21 each week. An additional group numbering 84 participated in four weeks of pilot testing. All were males stationed at Fort Knox, Kentucky. Members of the principal group ranged in age from 18 to 41. The primary source units of these participants included an armored brigade, a cavalry regiment, and an armor training brigade. Additionally, some of the officers had just graduated from the Armor Officer Advanced Course or the Armor Officer Basic Course.

In response to a troop support request from ARI, the supporting units provided participants in groups of seven vehicle commanders (four officers, three NCOs) and fourteen soldiers (NCOs and enlisted personnel) to serve as gunners and drivers. Unit leaders determined who would participate in the evaluation. All participants were required to hold armor Specialty Skill Identifiers (SSIs) or to be currently qualified in armor Military Occupational Specialties (MOSs). The participants within a group did not necessarily come from the same company, although same-company composition was generally true of groups from the armored brigade. As a general rule, obtaining intact crews was not possible.

All participants received a briefing explaining the purpose of the evaluation and the role they played in it. Each participant signed a Privacy Act Statement after listening to the provisions for ensuring his privacy and his right to withhold any information he might desire. The potential uses of the data to be collected were also explained.

Configuration of Test Company

Each week's group of participants was organized into a test company forming the core of the evaluation. The company modelled a tank-pure, three-platoon M1 main battle tank maneuver element. The 2d Platoon was completely manned, while the 1st and 3d Platoons each contained one manned and three semiautomated vehicles. Figure 2 illustrates the company configuration, differentiating between the seven manned and six semiautomated simulators. The company structure included no executive officer

or fire support officer. The crew structure (vehicle commander, gunner, driver) for a manned simulator was always the same.

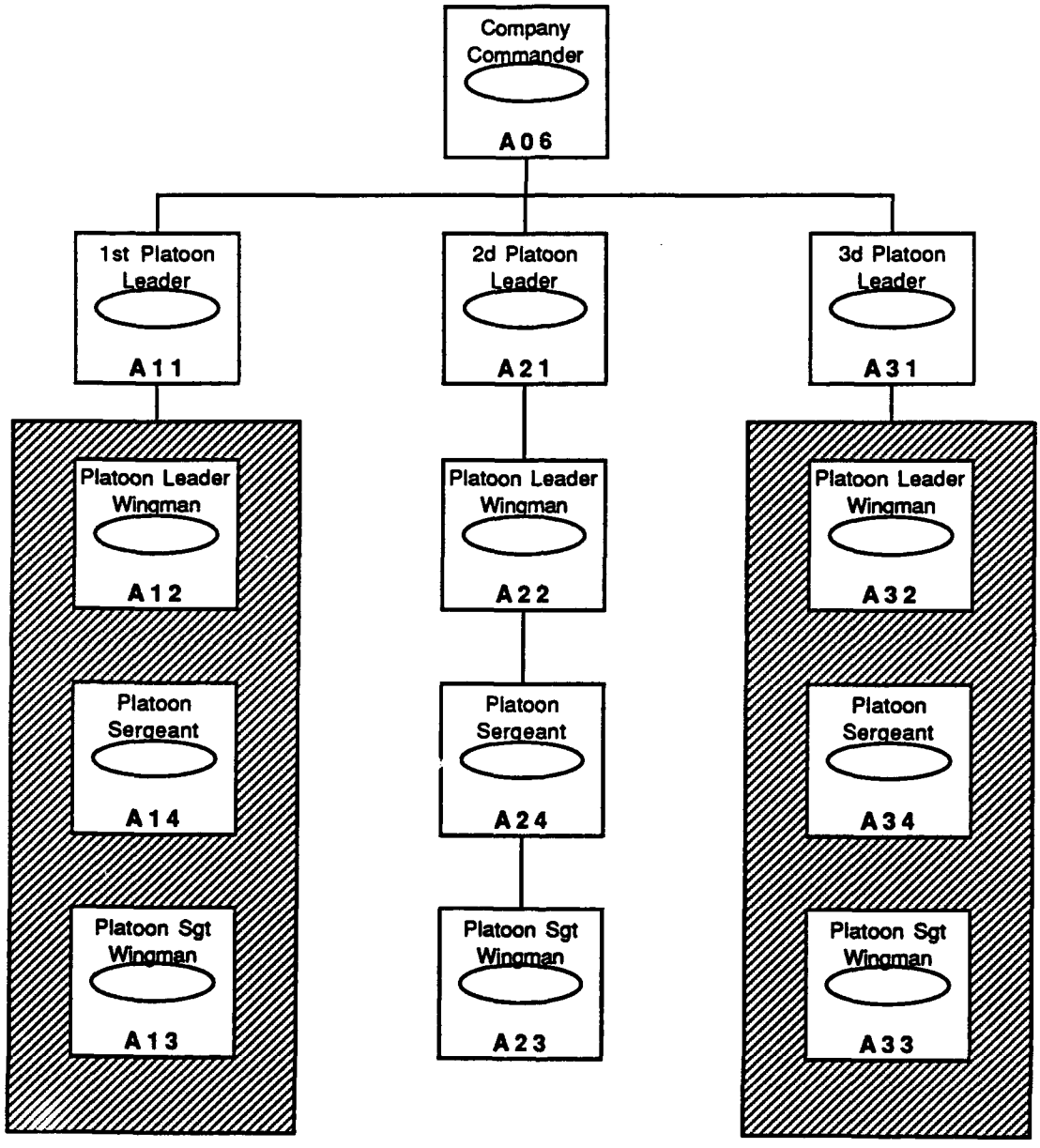

Figure 2. Illustration of the configuration of the test company. (Each square represents a simulated M1 tank, with role and call sign indicated. The six simulators within the shaded areas represent semiautomated vehicles; the other seven simulators were manned.)

In configuring company staffing, the senior commissioned officer of the group served as Co Cdr. The research staff randomly assigned the remaining three commissioned officers to the three Plt Ldrs' positions. The three senior NCOs were then assigned to the Plt Sgt and wingmen positions based on rank and time in grade. The remaining participants were divided into gunners and drivers, based wherever possible on their current duty positions. Gunners and drivers were then randomly assigned to crews, with the provision that no crew contain members who normally served together on the same crew. The result of this assignment process was a collection of ad hoc crews not accustomed to working together, which would correspond to a reconstituted unit formed after several days of battle.

To fill out the 1st and 3d Platoons, three semiautomated vehicles were tethered to each Plt Ldr's simulator. (Tethered vehicles are SAFOR vehicles coupled to a manned simulator for purposes of controlling movement and tactical formation.) Over the tethered vehicles the Plt Ldr could exert limited control. Software-controlled parameters largely determined their positioning and movement, based on the Plt Ldr's location and movement. A research team member role-played the TCs of the tethered vehicles for purposes of radio communications for both the M1 Baseline and CVCC conditions. For tethered vehicles in the CVCC condition, software routines generated digital burst message traffic which was transmitted directly to Plt Ldrs.

Research Team

The research team included control personnel, responsible for controlling all training and test exercises as well as collecting data, and research assistants, serving as both primary trainers and in-simulator data collectors. Team members were formally trained to ensure both proficiency and standardization.

Control personnel. Members of the exercise control room (ECR) staff role-played key battalion staff positions, controlled training and test exercises, and recorded observational data. The staff consisted of a Test Director, a Battle Master, an Assistant Battle Master, a SAFOR operator, and two Plan View Display (PVD) operators. Among the ECR staff were a research scientist with extensive military research experience, a C^2 subject matter expert (SME) with military operations and training experience, and two former armor officers. ECR manning requirements for this evaluation were developed based on procedures and staffing requirements from prior projects and on results obtained from pilot tests. Selected control personnel were cross trained on the duties, functions, and tasks of other ECR positions to provide flexibility and to allow test operations to continue in the event of an absence.

Research assistants (RAs). Under the supervision of an RA Coordinator, RAs served as trainers, in-simulator monitors, and data collectors. As trainers, they conducted all hands-on training of soldier-participants, including explaining and

demonstrating equipment functions as well as guiding and supervising practice exercises. During test exercises they collected observational data including notes on events or patterns which might influence later interpretation of data. They also monitored the operational status of the simulator and its automated C^3 equipment, summoning help when equipment failures occurred.

Test Facilities and Materials

This subsection describes the simulator facilities and CVCC equipment; the systems used for controlling scenarios; the materials used for training and testing; and the systems and materials used for collecting and analyzing data.

Figure 3 depicts the floor plan of the CCTB facilities, in which evaluation activities were conducted.

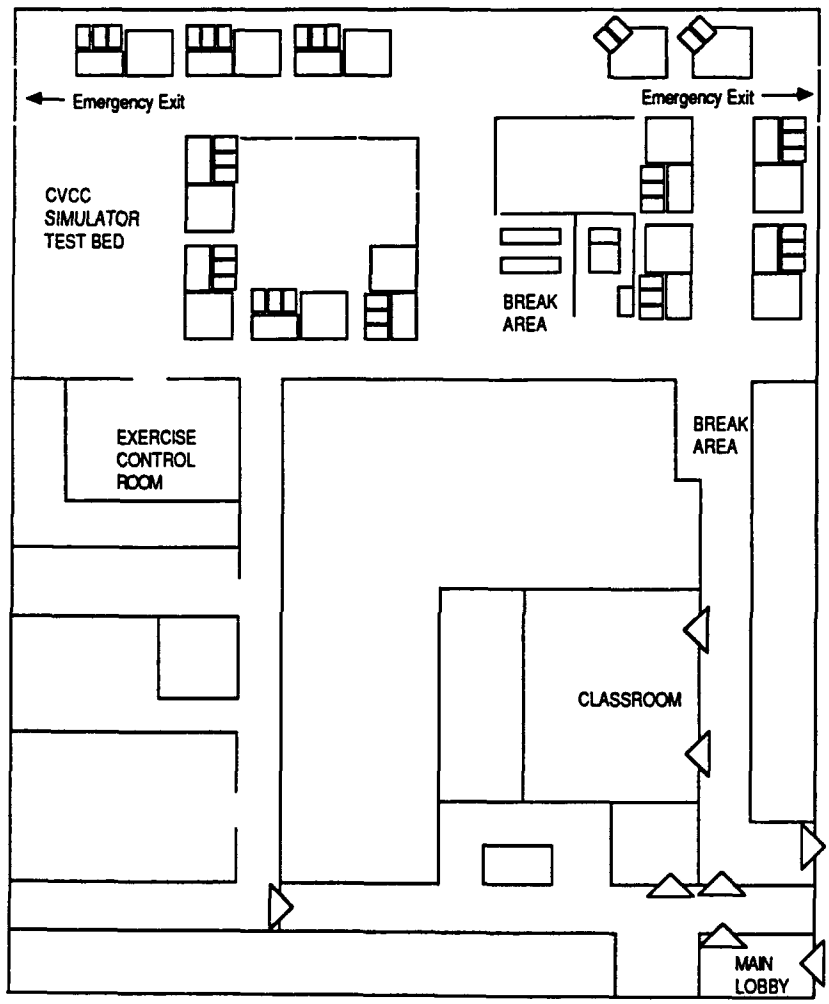

Figure 3. Schematic floor plan of the CCTB facilities.

Simulator Facilities

Seven M1 tank simulators in the CCTB facilities supported this evaluation. Table 3 lists the simulator capabilities which characterized the M1 Baseline and CVCC configurations. The key features common across both conditions included vision blocks in two crew stations (vehicle commander and driver), grid azimuth indicator, odometer, laser range finder (LRF), gunner's primary sight (GPS), GPS extension (GPSE) in the commander's station, turret reference display, and simulated SINCGARS (Single Channel Ground and Airborne Radio System) radio without terrain modeling capability. The M1 Baseline condition incorporated only equipment present in the fielded M1, except for the automatic loader, the grid azimuth indicator, the turret reference display, and the SINCGARS radio. The CVCC condition included the Command and Control Display (CCD) with POSNAV along with the CITV.

Table 3

Basic Capabilities of Simulator Configurations

Capabilities	M1 Baseline	CVCC
Navigation		
Vision blocks	X	X
Paper map w/overlays	X	X
Grid azimuth indicator	X	X
Odometer	X	X
Laser range finder (LRF)	X	X
CCD/POSNAV		X
Target acquisition/engagement		
Vision blocks	X	X
GPS/GPSE (w/thermal, 3X/10X, LRF)	X	X
Turret reference display	X	X
CITV (w/3X/10X, LRF, Target Designate, Target Stack)		X
Communications		
Intercom (w/in crew)	X	X
SINCGARS radio (voice)	X	X
Digital burst (reports & overlays)		X

In terms of physical layout, the three crew stations were identical across the two conditions. In the M1 Baseline condition, the CITV and CCD were turned off at all times. Figure 4 depicts the CVCC vehicle commander's crew station. Note the location of the CITV to the left of the CCD.

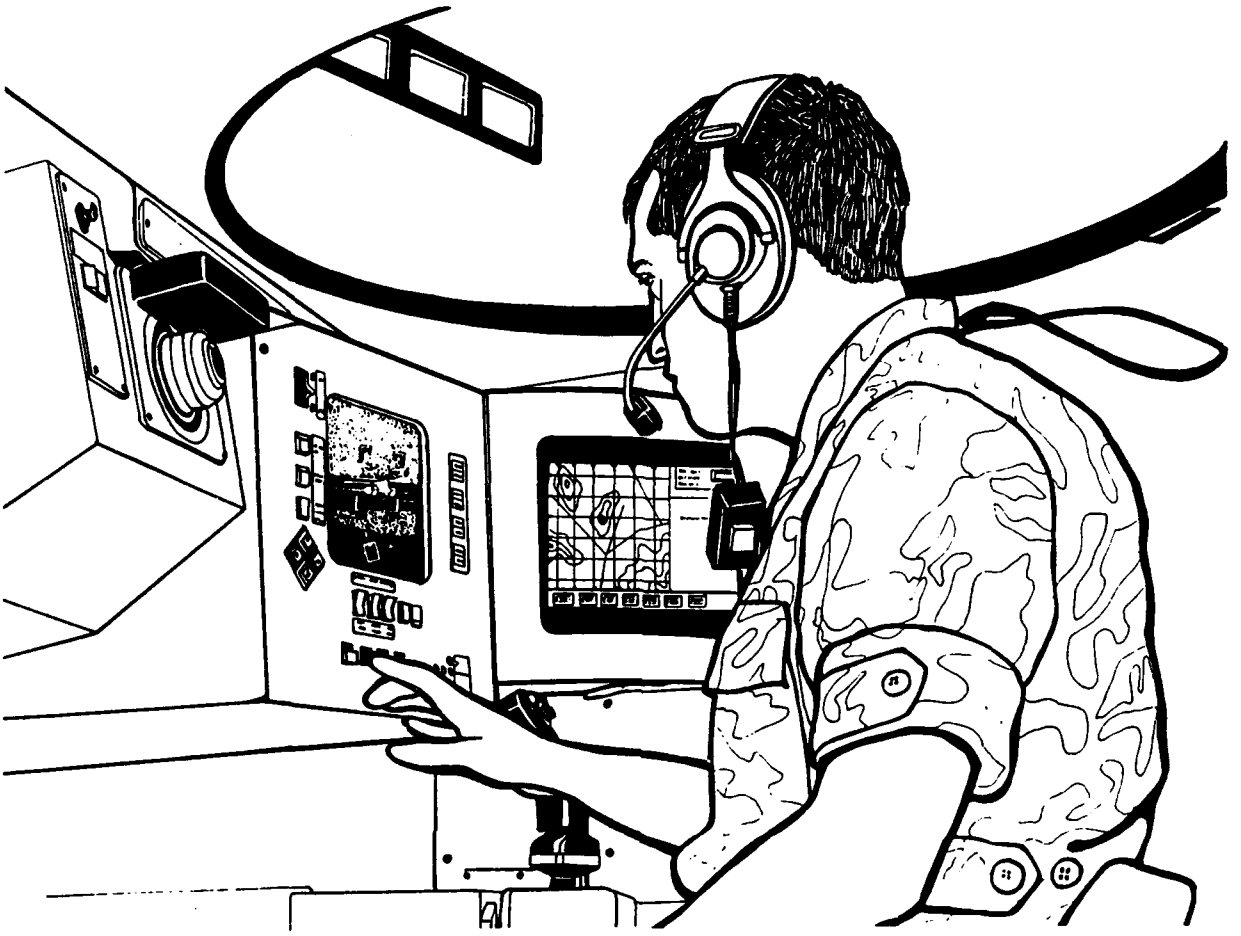

Figure 4. CVCC vehicle commander's crewstation.

Command and Control Display Configuration

The CVCC included the CCD pictured schematically in Figure 5. Du Bois and Smith (1990) have described an earlier version of the system, the IVIS (Intervehicular Information System). Modifications incorporated in the current version are reflected in the descriptions below. The 10.25-inch diagonal cathode ray tube (CRT) component displaying the CCD was mounted to the right of the vehicle commander. A 7 by 5.75 inch rectangular working area of the CRT display comprised the primary user interface. Five functional sections organized this interface: (a) full-feature, five-color digital tactical map (4.5 by 5.12 inches) with multi-component own-vehicle icon plus friendly vehicle icons; (b) information center displaying date/time group, own grid location, own vehicle heading, and own call sign; (c) fixed array of soft-switch menu keys accessing specific functions; (d) working menu area displaying queue/file listings, menus, and sub-menus; and (e) message receipt alert key.

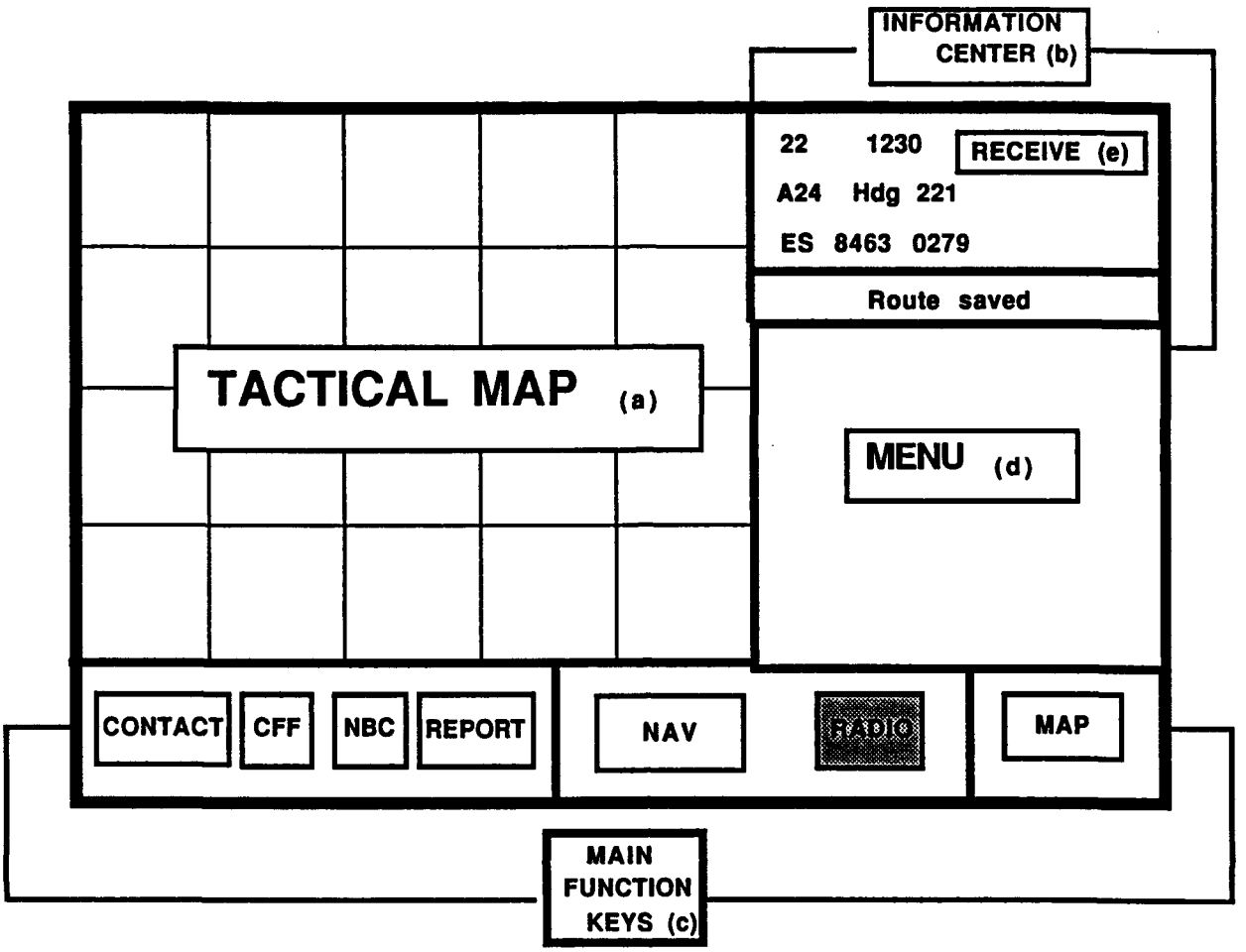

Figure 5. Schematic drawing of the Command and Control Display user interface. (Letters in parentheses correspond to descriptions of primary functional sections in text.)

Table 4 lists the basic capabilities of the CCD configuration. Smith (1990) described the CCD's functional features. A brief overview of the system follows.

Map functions. The basic tactical map was a Universal Transverse Mercator (UTM) grid representation of the terrain surrounding the tank's location, from an overhead perspective. Digital data in the SIMNET terrain database constituted the basis for all resident map graphics. Four map scales were available at all times--1:25,000, 1:50,000, 1:125,000, and 1:250,000--with at least a few seconds processing time required for rescaling. The configuration provided several additional display features for optional selection by the vehicle commander: contour lines, rivers, roads, vegetation, and UTM grid lines, all of which were color coded. Also, the system could display graphic tactical map overlays received digitally.

Table 4

Capabilities of the CCD Configuration

Navigation

- Grid & terrain map w/graphic overlays
- Own vehicle location & heading (digital)
- Own vehicle icon (position & direction)
- Friendly vehicle icons (position & call sign)
- Route waypoint icons
- Driver's steer-to display (analog & digital)
- Waypoint autoadvance (on call)
- Route transmission (digital burst)

Communications

- LRF input to reports (GPS & CITV)
- Prepare/send/receive/relay digital reports
- Receive/relay digital graphics
- Report-based icons

General characteristics

- Thumb control
- Touchscreen control
- Color display

Several map scroll functions enabled the vehicle commander to control positioning of the map in relation to his tank icon. The basic scroll function maintained the icon in the center of the map, scrolling the map as the tank moved. Alternatively, the vehicle commander could position his tank icon in an off-center location while the map scrolled under the icon. An option was to lock the map in position, maintaining a view of the same terrain segment regardless of where the tank moved. Finally, the vehicle commander could reposition the map to show a new terrain segment, allowing him flexibility to inspect icons or terrain features of interest.

The tactical map could display symbols (icons) representing selected battlefield information. These included report-based and route-based icons. When the vehicle commander prepared reports, digitally generated icons appeared on the map (e.g., CONTACT reports generated enemy vehicle icons). Waypoints generated using Navigation functions appeared on the map with connecting lines, forming graphic routes. The tactical map automatically displayed icons which represented all friendly vehicles located on the terrain segment currently displayed. This was labelled the "mutual POSNAV" feature. Finally, some icons (e.g., minefield symbols) signalled reports which were received digitally.

Navigation functions. The CCD enabled the vehicle commander to create and modify routes for navigation and to send route information to his driver. In addition, the configuration permitted any vehicle commander to transmit a route digitally to other vehicles in his unit. Routes were generated by designating up to six locations (waypoints) on the map. An icon for each waypoint appeared on the map, while lines connected successive waypoints. The vehicle commander could send waypoints to his driver one at a time--manually or automatically by means of an Autoadvance option.

The navigation subsystem included a steer-to display in the driver's compartment, mounted to the right of the steering column (T-bar). The steer-to display presented alphanumeric information about the tank's current and required heading as well as distance from the current waypoint. In addition, the display incorporated a graphic indicator with a pointer showing how the driver should steer to reach and maintain the proper heading.

Also of value in navigating and positioning was the directional own tank icon displayed on the tactical map. This helped maintain proper orientation and direction of movement. Both UTM grid location and grid azimuth heading were available in the CCD information center.

Report functions. The CCD supported preparation of reports by means of menu-driven screen forms. The vehicle commander was able to prepare any of the nine types of formal reports available on the CCD by filling in fields appearing in the working menu area. Table 5 lists these report types along with the number of fields and pages in each. See Appendix A for a complete listing of report formats. The vehicle commander could call up CONTACT, CALL FOR FIRE, and NBC (Nuclear/Biological/Chemical) report forms directly from the fixed menu keys. The remaining report forms required him to call up the Report menu first, then choose a report type from the options appearing in the working menu area.

Fill-in fields usually called for selecting inputs from option sets provided by the CCD. Fields dealing with location or heading information called for grid inputs from the tactical map or from lasing to a vehicle or terrain point. Blank fields were permitted. Since typically only four or five fields could fit in the working menu area, four of the reports required more than one "page" for complete presentation, the final page being a summary of all fields.

At any time the vehicle commander could leave a report preparation screen without completing or sending it. He could return to the report later for completion. He might, for example, leave to prepare another type of report, then return to work on the first report, finding it exactly as he had left it. Multiple types of reports could be open at the same time, but only one of a given type of report (e.g., NBC report) could be open at any time. No more than one report could be visible on the CCD screen at a given moment. The vehicle commander had the

option to delete a report if desired. Upon completing a report, the vehicle commander could transmit it digitally by a sequence of soft-switch presses.

Table 5

Report Preparation Forms Available on the CCD

Report Type	Number of option-input fields	Number of grid-input fields	Number of pages
CONTACT	4[a]	4[a]	1
CALL FOR FIRE	1	1	1
ADJUST FIRE	3	1	1
SPOT	9	2	3[b]
SHELL	2	1	1
SITUATION	8	2	3[b]
AMMUNITION	5	0	1
INTELLIGENCE	8	6	4[b]
NBC	7	2	3[b]

[a]Up to four paired ID-location fields could be filled in.
[b]Includes a final summary page.

Digital report transmission. A simulated radio interface unit (RIU) enabled the vehicle commander to transmit reports prepared on the CCD. A routing menu offered the option of sending any report on any radio net available for the vehicle commander's use (Figure 6), including simultaneous transmission on two nets for Co Cdrs and Plt Ldrs. For example, a Plt Ldr could send a report to the TCs within his platoon (platoon net), to the Co Cdr and the other Plt Ldrs (company net), or to all of them at the same time. A default net (based on transmission direction--upward or downward) existed for each report type. If a Co Cdr or Plt Ldr relayed or sent an INTELLIGENCE report, a FRAGO (fragmentary order), a digital overlay, or a digital route, the default was the downward-going net (the Plt Sgt and wingmen had no downward-going net). For all other reports the default was the upward-going net. Upon transmission, a report copy automatically transferred to the sender's "old" file, from which it could be retrieved later and resent. The system confirmed transmission with a "Message Sent" cue displayed in the information center, but it provided no feedback to the sender as to whether the addressees received and read the report.

When a vehicle commander received a transmitted report, three cues signalled its arrival: the message receipt alert key lighted up, an audible cue sounded in the vehicle commander's headset (three tone beeps for high priority reports, one beep for others), and an icon appeared on the tactical map, blinking for the first five seconds. (Report priority was based on immediacy of information. High priority reports included: CONTACT, CALL

FOR FIRE, ADJUST FIRE, FRAGO, INTELLIGENCE, and NBC reports.) For up to five minutes, a newly arrived report remained in the receive queue, with its associated icon remaining on the map. As high priority reports arrived, they went to the head of the queue. The vehicle commander could display the receive queue to view the report type, originator, and time received for each report, enabling him to select a desired report for display in the working menu area. The receive queue display presented up to five items at a time, with the vehicle commander having the capability to scroll forward and backward through the complete queue.

If the vehicle commander failed to retrieve a report from the receive queue within five minutes, the report automatically transferred to the old file for that report type (unless he was viewing the receive queue). In so doing, CONTACT reports and INTELLIGENCE reports automatically posted an icon to the map, i.e., displayed the icon on the map at the proper location. For other reports the associated icon, if not manually posted, disappeared from the map.

Once the vehicle commander selected a report to read, he could review it at his own pace. In the case of a multi-page report, only the summary page appeared. When ready to terminate his review, he could exit and file the report (with an option to post the report's icon to the tactical map), he could relay it, or he could delete it. The system design prevented the vehicle commander from modifying a received report. Unless he deleted it, he could subsequently retrieve the same report as many times as he desired.

If the vehicle commander decided to pass a report along to other members of his unit, he could exercise the option to relay it. Relaying a report involved the same steps as transmitting one. The same options for routing were available. The system did not limit the number of times a given report could be relayed or sent.

Control inputs. The vehicle commander controlled the operation of the CCD by means of a cursor appearing on the face of the display screen. He selected menus and functions by positioning the cursor on the desired key. The configuration afforded the vehicle commander the option of manipulating the cursor position by touching with his finger the face of the touch-sensitive screen or by using a thumb control mounted on his control handle. Touching the screen automatically jumped the cursor to the new position designated by the finger's contact with the screen. The actual location of the cursor was slightly offset above the finger tip to allow the vehicle commander to see it clearly. When satisfied with the cursor position, the vehicle commander removed his finger from the screen. This action initiated the menu or function corresponding to the key on which the cursor rested, or resulted in a map input (grid location or azimuth heading) to a report if the cursor rested on the map.

When operating the thumb control, the vehicle commander could move the cursor in virtually any direction at a variable speed. With the cursor resting on the desired key, release of the thumb control initiated the corresponding menu or function.

Utility functions. The CCD provided a small set of functions with which to manage prepared and received reports. Among these functions was the automatic transfer of reports from the receive queue to old files, along with the disappearance of the corresponding map icons, after five minutes. The vehicle commander could delete reports which he created, both during preparation and after transmission/filing. He could also delete unwanted reports received. The latter action could be accomplished without reviewing the contents of the report or after it had been filed. Deletion resulted in no record of the contents. To declutter the tactical map, the vehicle commander could delete icons one at a time or he could select a menu option to delete all icons older than a specified time.

Configuration of Radios

The simulated SINCGARS radio system serviced five radio nets--battalion, company, and three platoons. The manned simulators connected to these nets in a doctrinally realistic arrangement (Figure 6). The Co Cdr, Plt Ldrs, and Plt Sgt accessed two nets each, while the two wingmen accessed only one. In the CVCC condition, a simulated RIU linked the CCD with the simulated SINCGARS to enable transmission of messages via digital burst technique. The digital transmission routing options were the same as the voice net options except for the Plt Sgt, who could transmit and receive CCD messages on only the platoon net.

The maximum effective radio communication distance was approximately 35 km for the company nets and approximately 5 km for the platoon nets. The terrain geometry model for SIMNET was not ready for implementation in time for incorporation in this effort.

Commander's Independent Thermal Viewer Configuration

The CVCC included the CITV, which afforded the vehicle commander an independent battlefield viewing capability and an independent LRF. In terms of tactical utility, the diverse functions of this system spanned navigation, battlefield surveillance, target acquisition (including identification), target management, and fire control. Table 6 lists the functional capabilities of the CITV configuration.

Mounted directly in front of the vehicle commander, the CITV display included control switches around three sides of a central display screen (Figure 7). The switches on the right margin of the interface were nonfunctional. The vehicle commander controlled operation of the CITV via inputs through the functional switches and through push buttons on his control handle. The control handle was also used to manually control

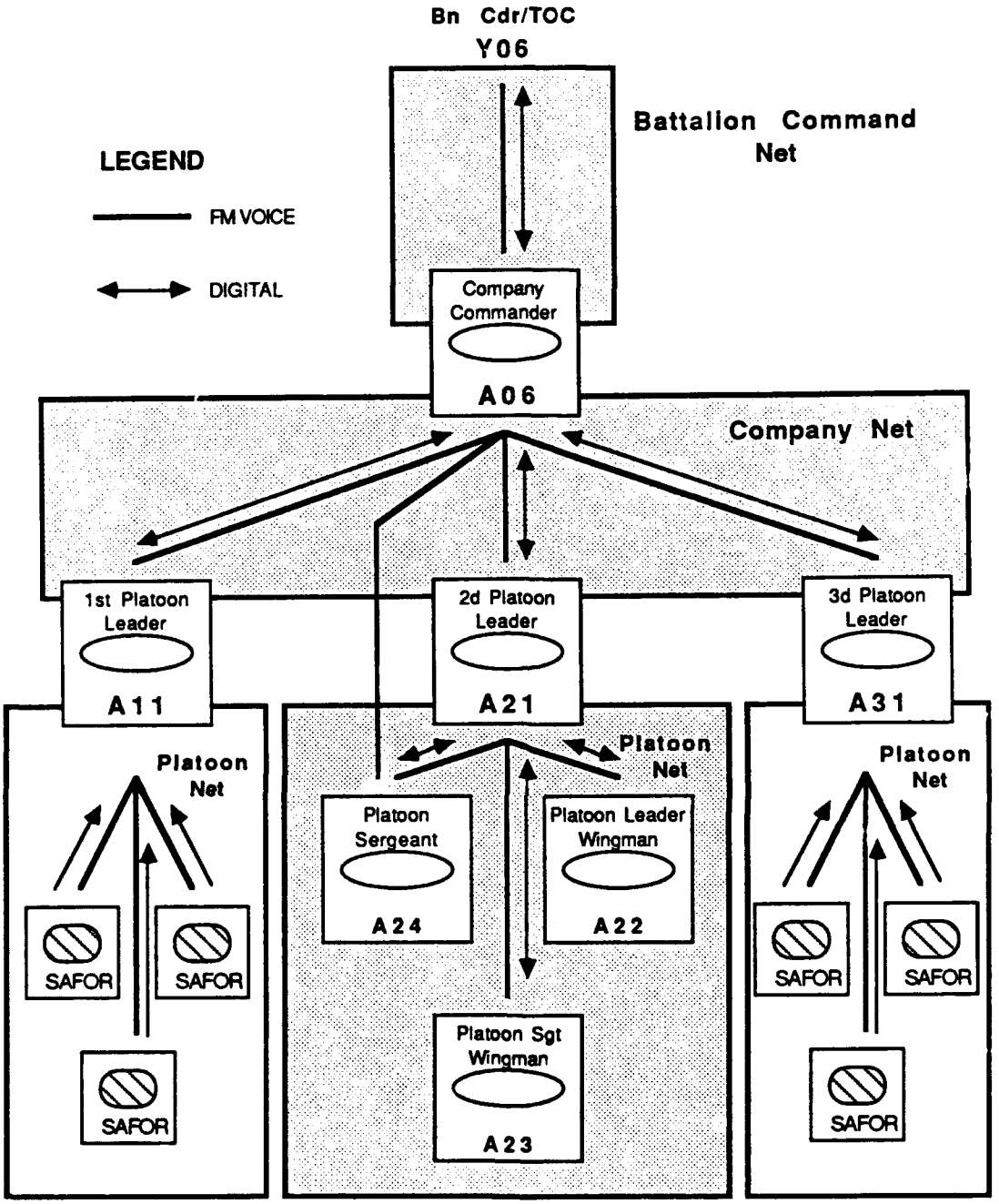

Figure 6. Schematic representation of simulated SINCGARS radio net configurations, showing the battalion command net, the company net, and the three platoon nets. (Each square with a call sign (e.g., A06) represents a manned M1 simulator. The squares labelled "SAFOR" represent platoon TCs role-played by an ECR controller.)

movement of the CITV sensor. The interface components consisted of: (a) rectangular (6.5 X 5.88 inches) monochrome CRT display screen with own vehicle icon and sighting reticle; (b) power switch with OFF, STANDBY, and ON positions (three-position

toggle); (c) push-button selector switches for basic mode (CITV, GPS); (d) push-button selector switches for operational mode (AUTOSCAN, MANUAL SEARCH, GLOS--Gun Line of Sight); (e) two-position push-button switch for polarity (WHITE-HOT, BLACK-HOT); (f) Autoscan control switches for setting sector limits and adjusting scan rate; (g) vehicle commander's Target Stack display with four push-button target selector switches and ON-OFF push-button switch; (h) gunner's Target Stack display similar to the vehicle commander's; (i) control handle push buttons for switching magnification (3X, 10X), operating the laser, and designating targets.

Table 6

Capabilities of the CVCC CITV Configuration

Independent thermal search
3X and 10X magnification
White-hot and black-hot polarity
Independent LRF
Gun Line of Sight (GLOS) lock-on
Manual search
Autoscan
Identification of Friend or Foe (IFF)
Target Designate
Target Stack
Own vehicle icon (directional, all parts moving)

Quinkert (1988) described the functional features of the CITV. The SIMNET CITV User's Guide (Heiden, 1989, pages 7-15) explains the operating features. (NOTE: The physical layout of the user interface shown in the User's Guide is distinctively different from the configuration used in this evaluation. The operating procedures were the same.) An overview of the system functions follows.

Basic modes. In the GPS mode, the CITV was functionally inactivated, with the last active scene from the sensor remaining static on the screen. Requiring the vehicle commander to use his GPSE for viewing, this mode enabled him to override the gunner in moving the turret/gun tube and firing. The CITV mode permitted the vehicle commander to select three modes of surveillance--GLOS, Manual Search and Autoscan. The GLOS mode slaved the CITV line of sight to the main gun alignment, except when the vehicle commander depressed his palm switch to activate Manual Search. The slaved alignment provided a view overlapping the gunner's view while enabling the vehicle commander to operate his own LRF and change magnification and polarity. The Manual Search and Autoscan capabilities, both providing independent surveillance, are discussed later. The vehicle commander could not fire the main gun with his CITV activated.

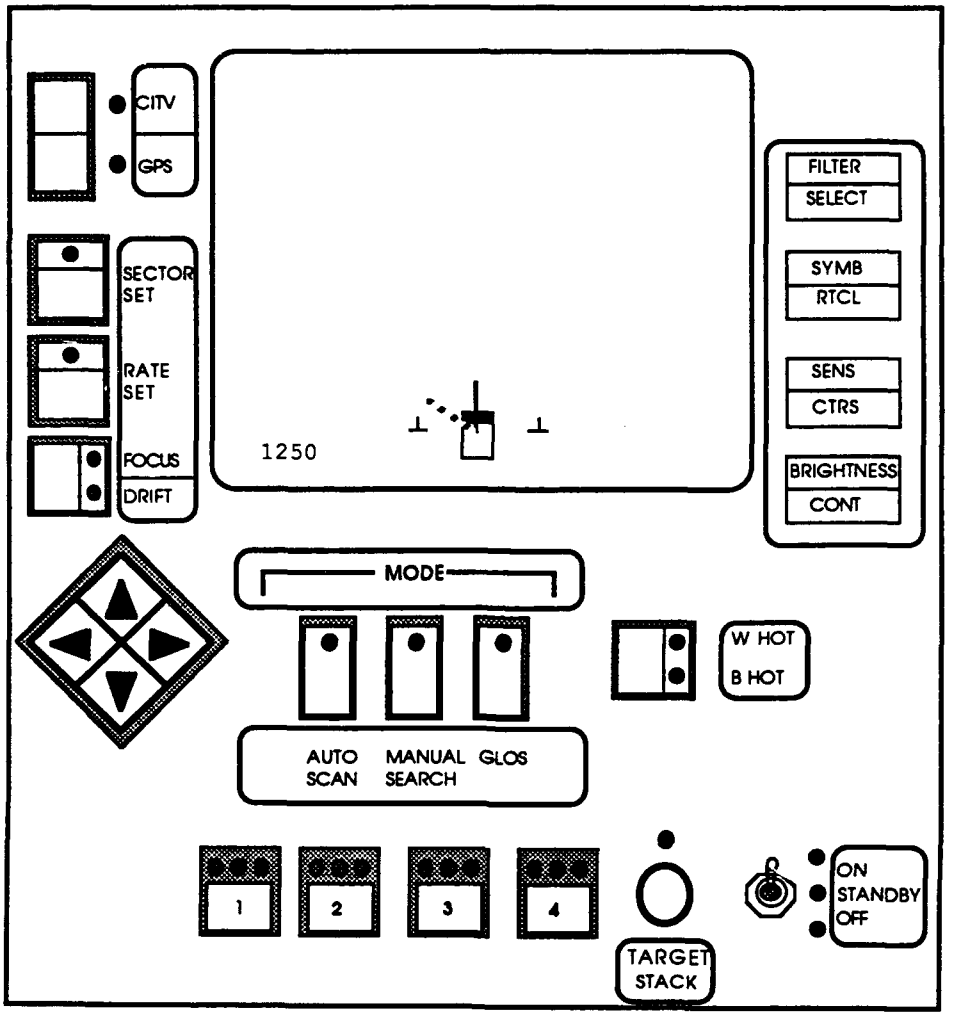

Figure 7. Schematic drawing of the CITV user interface.

In all CITV modes the display screen presented two optional fields of view: wide field (3X magnification, 7.5 X 10 degrees) and narrow field (10X magnification, 2.5 X 3.3 degrees). In providing uninterrupted horizontal sweep capability, the system afforded a 360 degree field of regard, with a vertical range from 20 degrees elevation to 12 degrees depression. According to his preference, the vehicle commander could select White-Hot or Black-Hot display options. In White-Hot mode, warmer objects within the field of view appeared "white" against a darker background. In Black-Hot mode, warmer objects appeared black against a lighter background.

The own tank icon present on the display screen was fully consistent with the own tank icon appearing on the CCD tactical map. The tank hull portion of the icon rotated to represent the tank's grid azimuth heading. The main gun indicator depicted the true direction of the turret/gun. The CITV indicators included

the CITV's line of sight direction as well as the Autoscan sector limit markers.

Manual Search. In selecting Manual Search, the vehicle commander could control the CITV's line of sight manually by manipulating his control handle. Both direction (horizontal, vertical, and oblique) and speed of movement could be controlled simultaneously. This mode allowed the vehicle commander to vary at will his pace and pattern as he searched for targets. It preserved access to other control options such as magnification, polarity, and Target Designation.

Autoscan. Autoscan permitted the vehicle commander to sweep automatically the CITV's line of sight back and forth across a specified sector at a selected rate of speed. The search pattern required no input from the vehicle commander once initial parameters were set. Setting or resetting left and right sector limit markers defined the portion of the field of regard to be scanned. To adjust scan rate, the vehicle commander could increase or decrease the current rate, which began at a default value upon initialization. The entire 360 degree field of regard could be selected as the scanning sector, if desired. As with Manual Search, Autoscan maintained availability of secondary control options such as polarity, magnification, and Target Designation. The latter function required the vehicle commander to activate a temporary Manual Search option by depressing his palm switch.

Independent LRF. The CITV system included a laser capability independent of the standard (GPS) LRF. The vehicle commander could exercise this capability in GLOS, Manual Search, and Autoscan modes; lasing in the latter mode required interruption of scanning to stabilize the sight picture. Each lase produced a range-to-target reading in meters, displayed in the lower left corner of the display screen; this reading could indicate flawed determinations and double returns. Lasing also supported the IFF function, generating symbology characterizing the target as friendly, enemy, or uncertain. This symbology appeared in the upper left portion of the display. The IFF function modelled an 85 percent accuracy rate.

Target Designation. In the Manual Search and Autoscan modes, the vehicle commander could use the Designate function to quickly hand off a target to his gunner. Having identified an enemy target for immediate engagement, the vehicle commander pressed the DESIGNATE button on his control handle. This rapidly slewed the main gun to the CITV's line of sight, overriding the gunner's controls. The vehicle commander then could hand off the target to the gunner.

Target Stacking. The CITV configuration incorporated a target management feature referred to as Target Stacking. In both the Manual Search and Autoscan modes, the vehicle commander could use this feature to cue the gunner about available targets. After identifying an enemy target by lasing, the vehicle

commander pressed one of four buttons to mark the target's location. He could cumulate up to four targets in the stack, placing each in the desired priority (number one being highest priority). As the vehicle commander stacked targets, cuing lights on the gunner's display came on and, for each target, two light emitting diodes indicated the relative position of the target with respect to the direction of the main gun (left, right, or centered). The gunner could use these indicators to anticipate the direction in which the turret would slew after pushing a target button. After the gunner engaged a target selected from the stack, it dropped from the stack without impacting the standing of other targets in the stack.

Exercise Control Systems

The ECR housed the stations which controlled tactical exercises (Figure 8). Comprising these stations were: (a) two PVDs (Plan View Displays)--one for battalion-level monitoring, one for company-level monitoring; (b) four simulated SINCGARS radios handling the battalion, company, 1st Platoon, and 3d Platoon nets, respectively; (c) Management, Command, and Control (MCC) system for monitoring and controlling the status of simulators; (d) SIMNET Control Console (SCC) for initializing simulation elements; (e) SEND station for preparing, retrieving from storage, and transmitting digital reports at the battalion staff level; (f) stand-alone CCD (SACCD) and LISTEN station for monitoring digital message traffic; (g) SAFOR workstations for controlling semiautomated forces, both friendly (blue forces, or BLUFOR) and enemy (opposing forces, or OPFOR); and (h) Fire Support Element (FSE) terminal for controlling indirect fires. A brief description of these stations follows.

Plan View Displays. Two PVDs (battalion and company level stations) afforded the primary monitoring capabilities during the execution of the training and test scenarios. The PVD display screen provided the control staff with a real-time top-down or bird's eye view of the battlefield. All vehicles, aircraft, gunnery targets, and impacting artillery and mortar fires were displayed. In addition, graphic control measures, grid lines and coordinates, lasing, and direct fire engagements were also available for viewing. Through a series of keyboard commands the PVD operator could insert a "flag" or time marker into the data stream to denote a significant or critical event useful during later analysis. The PVD capabilities included map manipulation, vehicle identification, intervisibility plotting, and a number of other functions (see Du Bois & Smith, 1989).

SINCGARS radios. Four simulated SINCGARS radios monitored operational radio nets in the ECR. The battalion command net, located at the battalion PVD station, was used by the Battle Master to control the execution of each test scenario. The company command net was monitored at the company PVD station to gather data on voice messages transmitted by the Co Cdr. The 1st and 3d Platoon command nets were monitored by the SAFOR station

operator, who used his radios to pass on information representing the semiautomated tethered vehicles filling out those platoons.

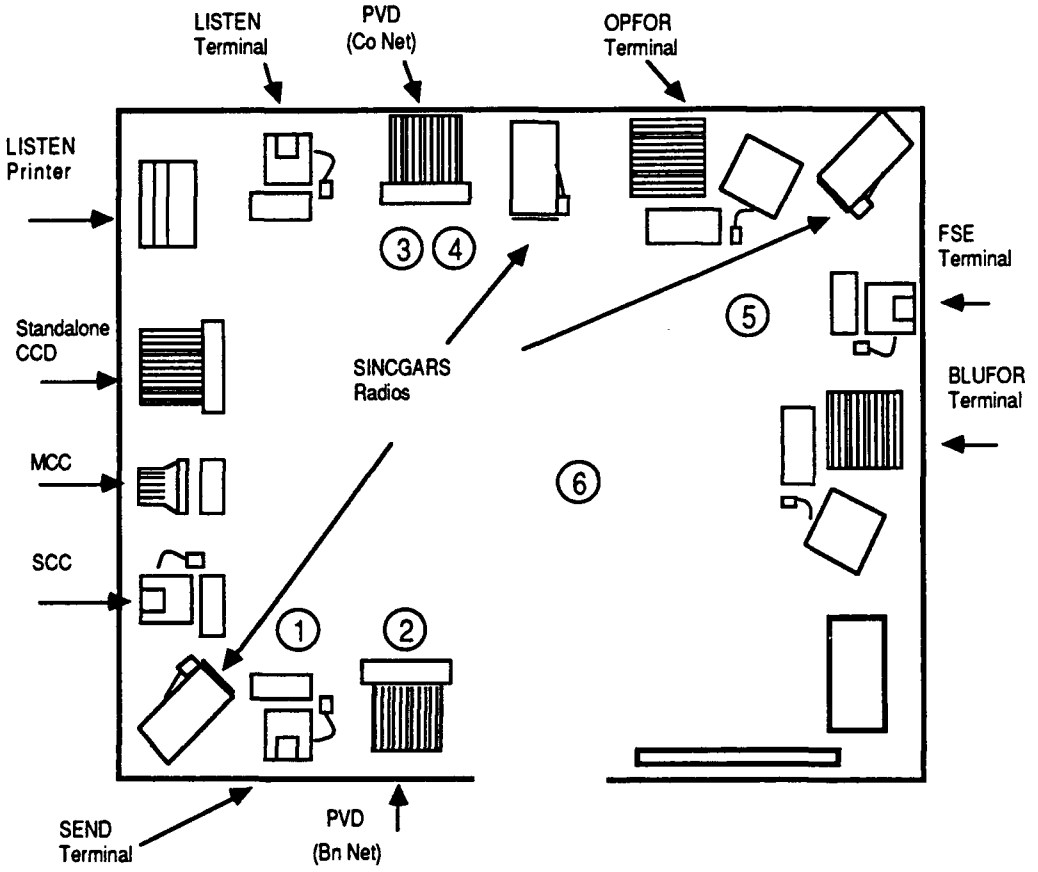

Figure 8. Schematic floor plan of the ECR showing location of equipment and normal positioning of control personnel.

Management, Command and Control system. The MCC system served two roles during this evaluation. First, it provided a system for setting up and managing the simulation, and second, it was able to simulate certain elements of the battlefield environment required for the evaluation. Initialization files were developed and installed on the system that defined the terrain database, the exercise identifier, simulator parameters, and unit organizations. These files allowed the ECR staff to repeatedly call up and execute scenarios in a nearly identical manner. Once initialized the MCC, upon query, provided a status read-out on all operational manned simulators.

SIMNET Control Console. A component of the MCC system, the SCC was used to initiate the MCC's involvement in an exercise and to initialize most of the elements simulated by the MCC system. Through it the ECR staff placed vehicles (simulators) and gunnery targets in specific locations on the terrain database. Standard files for each scenario allowed all vehicles and targets to be placed on the terrain database with only a few key strokes. The SCC also provided the ability to "reconstitute" or restore any elements that may have malfunctioned or "fallen off the net."

SEND station. During exercises involving the CVCC, the SEND station enabled the Battle Master to send scripted, digital messages to the Co Cdr via digital burst transmission. The station provided the capability to develop and store individual messages or a set of messages for later use. In multiple message files the SEND station also provided the capability to transmit messages at controlled intervals.

Stand-alone Command and Control Display. Used only in the CVCC condition, the SACCD allowed the Battle Master to communicate on-line with the Co Cdr through digital messages. The SACCD represented the CCD in the notional battalion commander's vehicle; it also provided control personnel with insights into what the Co Cdr was seeing on his CCD. This station was also used to create overlays which could be transferred to the simulators.

LISTEN station. The LISTEN station provided the ECR staff with a printout and a disk copy of digital messages transmitted by the manned simulators, the SEND station, the SACCD, and the tethered vehicles. The record included the time the message was sent, the message originator, the time the message was relayed, and the contents of each message.

Semiautomated forces workstation. The SAFOR workstation constituted the interface for controlling the semiautomated vehicles. The SAFOR operator controlled both BLUFOR and OPFOR through two terminals. Each terminal provided a color map display that showed the current state of the battlefield. A combination of keyboard and mouse device provided input capabilities. The operator could zoom or pan to any point on the map display. Features such as contour lines, UTM grids, roads, water, vegetation, graphic control measures, and buildings could all be displayed. Engagement and speed parameters for SAFOR vehicles could be entered through the keyboard. Initialization files for each scenario allowed both BLUFOR and OPFOR units to be called up, in their correct starting locations, with simple keyboard commands. The SAFOR operator also provided indirect artillery and mortar fires through the FSE terminal, via key stroke entries, or the "bomb button" option, by positioning a cursor on the map display with the mouse and then clicking a button on the mouse.

Training Materials

The training of participants followed the "crawl-walk-run" approach, beginning with individual training on equipment and proceeding through crew practice to platoon and company exercises. Individual training emphasized use of the CCD and CITV in the CVCC condition and SIMNET navigation in the Baseline condition, relying mainly on classroom briefings and guided hands-on sessions in the simulators. Training of gunners and drivers involved seat-specific orientation and guided practice. Enabling the ad hoc tank crews to gain experience as teams, crew training encompassed tactical navigation, target acquisition and engagement, and reporting. Unit training entailed a platoon training scenario followed by a company training scenario. This sequence of training exercises was designed to progressively develop and integrate individual skills, crew coordination, platoon activities, and company operations in the simulation environment.

The multi-stage sequence of training sessions--classroom, hands-on, crew practice, and unit practice--required a variety of materials. Among these were lecture-style materials for classroom training, script-like outlines and simple tests for one-on-one training, trainer checklists for unit exercises, company standard operating procedures (SOP) and navigational aids for vehicle commander use, and operational specifications for controlling unit exercises. Copies of primary training materials can be found in Quinkert and Atwood (in preparation).

Classroom briefings. For the classroom instruction sessions, view-graphs served to organize and standardize instructor presentations. The following view-graph packages were used: (a) introduction and overview, explaining the evaluation's purpose and objectives, the general methodology, the week's schedule of events, privacy considerations, and facility rules; (b) CCTB orientation, comparing the simulators to the actual M1 tank, emphasizing features unique to the simulators, and overviewing key equipment components; (c) SIMNET navigation briefing (M1 Baseline only), explaining SIMNET map reading, protractor usage, dead reckoning, terrain association, resection, and polar plotting; (d) CITV orientation (CVCC only), summarizing the hunter-killer concept, describing the CITV's functional capabilities, and suggesting some considerations for tactical employment; and (e) CCD orientation (CVCC only), reviewing the system's evolution and benefits, overviewing the basic functions, and suggesting potential tactical applications.

Seat-specific guides. A training outline emphasizing the differences between the actual and simulated M1 tank was used for small-group orientations to specific crew stations (vehicle commander, gunner, driver). Tailored to the CVCC or M1 Baseline, respectively, this outline standardized the seat-specific orientations given to all participants. It included practice for trainees on selected tasks, applicable during vehicle commander training only.

Hands-on outlines. In conducting one-on-one training to familiarize CVCC vehicle commanders with the CCD and CITV in the simulators, the RAs used outlines listing the points to be made and the equipment functions to be demonstrated/explained. These outlines ensured standardization of each hands-on session. A uniform sequence was followed for each function: explanation of a function's purpose, followed by a step-by-step explanation and demonstration, and ending with practice by the vehicle commander.

Diagnostics. Individual training phases concluded with scheduled diagnostic tests. These tests helped determine if a vehicle commander was prepared to continue training and provided feedback about the effectiveness of the training program. Three separate diagnostics addressed the SIMNET M1, the CITV, and the CCD, respectively. The SIMNET M1 diagnostic dealt with use of the grid azimuth indicator and turret reference display, whereas the CITV and CCD diagnostics covered the major functional features of those respective systems. Each test consisted of a series of tasks, instructions for which were read by the trainer. The format required the trainer to make a pass-fail judgment by marking "Go" or "No-go" for each task. To assist the trainer, the diagnostic summarized the set of steps defining correct performance of each task.

Company SOP. The company SOP expressed the general guidelines to be followed in training and test exercises. Representing current doctrinal principles, the guidelines constituted the rules applying to maneuver, engagement, communication and reporting, combat support, combat service support, and C^2. The SOP for M1 Baseline companies defined the format for each structured report.

Training scenarios. The situations and events comprising each training exercise were specified in scenarios, developed by armor SMEs and then validated by the Directorate of Combat Developments (DCD), U.S. Army Armor School. Based on current warfighting doctrine, these scenarios combined typical elements of offensive and defensive combat operations to represent realistic battles staged on terrain surrounding Fort Knox, Kentucky. Designed to take approximately two hours to execute, each scenario contained phases organized around primary and follow-on missions. Serving as a simulation blueprint, each scenario provided the script used by the ECR staff to implement unit training in a consistent manner. There were two separate training scenarios--one each for the platoon and company exercises. Table 7 summarizes the structure of the company training scenario.

Corresponding to each training scenario was a doctrinally correct operations order (OPORD) detailing the tactical situation, the unit's mission in Phase I, and related information. The OPORD provided the basis for the unit to plan its tactical execution of Phase I. FRAGOs specified the missions for follow-on phases in each scenario.

Table 7

Tactical Structure of Company Training Scenario

Phase	Major activities
Initial planning	Mission briefing, preparation
I. Seize Objective Mink	
A. Movement	Move to objective
B. Enemy engagement	Fight enemy platoon
C. Consolidation	Prepare hasty defense
II. Delay on BP 10	
A. Pre-engagement	Prepare defensive positions
B. Enemy engagement	Fight MRB, tank company, Hinds
C. Displacement	Displace to BP 11
III. Defend BP 11	
A. Pre-engagement	Prepare defensive positions
B. Enemy engagement	Fight MRB, Hinds

Note. BP = battle position; MRB = motorized rifle battalion.

Unit training checklists. During crew, platoon, and company training, a checklist served to remind the trainer of the SIMNET M1, CITV, and CCD functions the vehicle commander was supposed to practice or exercise. For the M1 Baseline condition, the checklist keyed only on navigating and operating the SIMNET M1. Listing each function separately, the checklist called for the trainer to "check" each when he observed it being performed. This process provided a basis for the trainer to prompt the vehicle commander to use those functions which he appeared to be overlooking or ignoring.

Navigation aids. Each vehicle commander used a standard set of materials to help him navigate during training scenarios. These included: SIMNET terrain maps housed in clear plastic map cases, operations overlays drawn by hand on clear acetate, grease pencils for drawing overlays and map notations, duct tape for securing overlays to map cases, map protractors for plotting azimuths, and rulers for measuring distance (M1 Baseline only).

Test Scenarios

Test scenarios consisted of a series of realistic battles designed to evaluate tank companies as they maneuvered, fought, and communicated in a simulated combat environment. These scenarios were developed by armor SMEs in DCD, using current warfighting doctrine, and were validated by members of the Command and Staff Department. They were set on terrain surrounding Fort Knox, Kentucky, and were designed to take

approximately two hours and thirty minutes for execution, exclusive of initial planning time and break periods.

To provide a reasonably broad range of performance requirements, two scenarios were developed: a movement to contact/hasty attack scenario and a delay/hasty defense scenario. These were chosen because they provide situations that: (1) require units to maneuver while in contact with an enemy force, (2) require rapid responses to changing situations, and (3) provide objective markers of mission completion. Also, prior research had shown that both types of missions are suitable for execution and quantification within the CCTB environment.

The structure of each scenario required Co Cdrs and Plt Ldrs to repeatedly plan, coordinate, and execute combat operations in fluid, demanding battlefield situations. Both scenarios contained three phases, each organized around a core of C^3 and maneuver activities. The multiple phases generated repeated opportunities for performance of key tasks: (1) mounted movement, (2) negotiation of terrain, (3) navigation, (4) target acquisition, (5) target engagement, both direct and indirect fire, (6) acquisition and transmission of information, both enemy and friendly, (7) receipt and execution of new missions, (8) assessment of the situation, and (9) issuance of orders.

The structure of the movement to contact scenario is outlined in Table 8, while Table 9 shows the structure of the delay/defense scenario.

Table 8

Tactical Structure of Movement to Contact Test Scenario

Phase	Major activities
Initial planning	Mission briefing, preparation
I. Seize Objective Bronze	
A. Movement	Encounter destroyed vehicles
B. Enemy engagement	Fight two MRPs, tank platoon
C. Consolidation	Prepare hasty defense
II. Seize Objective Silver	
A. Mission planning	Receive FRAGO, plan
B. Movement/engagement	Fight MRP
C. Consolidation	Prepare hasty defense
III. Seize Objective Gold	
A. Mission planning	Receive FRAGO, plan
B. Movement/engagement	Fight two MRPs, tank platoon
C. Consolidation	Prepare hasty defense

Note. MRP = motorized rifle platoon.

Table 9

Tactical Structure of Delay/Defense Test Scenario

Phase	Major activities
Initial planning	Mission briefing, preparation
I. Delay on BP 10	
A. Pre-engagement	Prepare BPs, assist scouts
B. Enemy engagement	Fight MRB(+)
C. Displacement	Displace to new BP
II. Move to/defend BP 14	
A. Pre-engagement	Receive FRAGO, plan, move to new BP, set up defense
B. Enemy engagement-1	Fight tank company, MRP
C. Enemy engagement-2	Fight MRC(-), two Hinds
III. Move to/defend BP 13	
A. Pre-engagement	Receive FRAGO, plan, move to new BP, set up defense
B. Enemy engagement	Fight MRB(+), Hinds

Note. BP = battle position; MRB = motorized rifle battalion; MRC = motorized rifle company; MRP = motorized rifle platoon.

The movement to contact scenario (Appendix A) portrayed an armor heavy task force conducting a passage of lines and a movement to contact in order to re-establish contact with an enemy force that was withdrawing and consolidating in defensive positions. Shouldering the main effort of a brigade-sized operation, the task force commander's intent was to move rapidly, bypass enemy elements smaller than a platoon, find the enemy, and maintain contact. The manned tank company (designated A Company), in an armor pure configuration, served as advance guard for the task force. OPFOR elements were arrayed in a typical Soviet security zone configuration, with platoon-sized or smaller elements placed within the task force's zone of action. OPFOR vehicles consisted of BMP-2 armored personnel carriers and T-72 main battle tanks.

The delay/defense scenario (Appendix A) portrayed an armor heavy task force conducting a high risk delay. The primary objective was to slow the enemy advance and force the enemy to commit his second echelon regiments. The task force was to accept the battle handoff after assisting a brigade-sized element in a rearward passage of lines, and to be prepared to conduct its own rearward passage of lines on order. The task force commander's intent was to disrupt enemy pursuit, attrit first

echelon battalions, and maintain constant contact while avoiding decisive engagement. In an armor pure configuration, A Company's instructions were to cover the task force's western flank. Portraying the OPFOR was a typical Soviet motorized rifle regiment task organized as part of the first echelon of a motorized rifle division conducting the main attack for a combined arms army. These forces were equipped with BMP-2 armored personnel carriers and T-72 main battle tanks.

Each scenario included a set of tactical control documents used to brief the starting mission to the Co Cdr and to initiate his planning process. These documents--OPORDs and graphic overlays--were reviewed by armor SMEs and pilot tested prior to being finalized. They provided the units with their objectives, the context within which they were expected to operate, and the minimum necessary guidance for conducting operations. They allowed the Co Cdr moderate latitude in planning his execution of the mission. Each document was required to be doctrinally correct, tactically feasible, and realistic.

In developing the orders, care was taken to minimize the decision making required of the Co Cdr and his Plt Ldrs. The purpose of the evaluation was to compare the automated capabilities of the CVCC configuration with existing technology, not good planners versus bad planners. To avoid obscuring effects related to equipment capabilities, it was important to preclude the confounding influence of variable planning abilities. Consequently, the orders were prepared in sufficient detail to enable the Co Cdr and Plt Ldrs to immediately begin planning mission execution, bypassing development of tactical options and deciding among them.

Two OPORDs were required: a task force OPORD and a company OPORD (Appendix A). The former set the larger tactical situation and context; the latter enumerated the specific missions and tasks assigned to A Company. Accompanying the OPORDs were a task force operations overlay (Appendix A), specifying minimum control measures, and a task force fire support overlay, designating pre-planned indirect fire concentrations. Additional materials supported mission planning and execution: SIMNET maps of the battlefield terrain, encased in tactical map cases; blank acetate and grease pencils for drawing overlay copies; duct tape for affixing overlays to map cases; map protractors; and, for M1 Baseline vehicle commanders, distance rulers.

The second and third phases of each scenario began with a task force FRAGO spelling out the new mission and changes in the tactical situation. Each FRAGO (see Appendix A) was scripted for voice radio transmission in the M1 Baseline condition. In this condition, the FRAGO's concept of operation paragraph specified the control measures required to execute the new mission. In the CVCC condition, a pre-prepared digital FRAGO included an overlay to be posted on the tactical map. To compensate for limited text capability, the digital FRAGO was supplemented by a brief voice radio script for each phase.

To standardize initial terrain parameters, computer files controlled the initial placement of simulators for all scenarios. Computer files also standardized the digital overlays used by ECR personnel to monitor scenario execution and those transmitted digitally to vehicle commanders in the CVCC condition. Finally, pre-prepared reports for digital transmission to vehicle commanders in the CVCC condition were stored in computer files.

Automated Data Collection and Analysis System

The Data Collection and Analysis (DCA) system provided automated data recording, reduction, management, and analysis functions. Within this system, DataLogger handled automated data collection, recording data packets on-line. Data recording occurred in the real-time, digital domain, storing information packets broadcast by each simulator over an Ethernet. Data samples were driven by events (e.g., a CCD soft-switch press) or by timed cycles (e.g., sampling every 30 sec). In the ECR, the two PVD stations provided the means for operators to embed event "flags" in the DataLogger recordings. Representing key events, such as the start of an exercise, radio transmission of a report, or crossing of a phase line, these flags served as markers to be used during data reduction. To monitor CCD reports transmitted via digital burst, a LISTEN system displayed all reports on-line and recorded them in a computer file.

Two DCA subsystems handled off-line reduction and analysis of DataLogger recordings: DataProbe[3], extracting and structuring data into intermediate files; and RS/1[3], analyzing data from the intermediate files by means of standard library routines as well as tailored programs.

Manual Data Collection Materials

A variety of instruments served to collect soldier-report and investigator observational data. These instruments included soldier-completed questionnaires, researcher-completed observation logs, and map plot exercises (Table 10).

[3]DataProbe and RS/1 are registered trademarks of Bolt Beranek and Newman Inc.

Table 10

Listing of Manual Data Collection Instruments

Instrument	Completed by:	Type of data
A. Biographical questionnaire	All partic's	Factual/recall
B. SIMNET training questionnaires		
Training Evaluation	Veh Cdrs	Rating scale
Ease of Learning	Veh Cdrs	Rating scale
Training Time Needed	Veh Cdrs	Rating scale
C. New equipment training questionnaires		
Type of Training Required	Veh Cdrs	Categorical
Time to Train	Veh Cdrs	Point estimate
D. SMI questionnaires		
CITV Evaluation	Veh Cdrs	Rating scale
CCD Evaluation	Veh Cdrs	Rating scale
Gunner's Evaluation	Gunners	Rating scale
Driver's Evaluation	Drivers	Rating scale
E. Map plot exercises	Veh Cdrs	Recall
F. Research Assistant logs	RAs	Factual/event Rating scale
G. Plan View Display logs	ECR staff	Factual/event Text

Biographical questionnaire. This questionnaire was designed to obtain limited information regarding demographic variables and military experience from each participant. This information provided a profile of participants in each group.

Two versions of the Biographical questionnaire were developed: one each for officers and enlisted personnel. Each included basic information such as age, rank, military specialty, and time in service. Additional items recorded experience with various armored vehicles, experience in each tank duty position, military courses completed, National Training Center (NTC) experience, Unit Conduct of Fire Trainer (UCOFT) experience, and experience in TO&E (Table of Organization and Equipment, or combat maneuver) units. Participants were asked about previous experience with SIMNET, including participation in SIMNET research efforts. They also were asked to provide information about their level of education and familiarity with computers. The two versions included different lists of duty positions and

military courses to use in indicating years/months of experience. Questions about the amount of time as a commissioned officer and source of commission were unique to the officers version. Both versions of this questionnaire appear in Appendix B.

Training questionnaires. Five paper-and-pencil questionnaires were developed to elicit participant responses and opinions regarding training aspects of the equipment used in the evaluation. Three of these focused on the training received during the evaluation (quality, clarity, and time needed) and the ease with which participants were able to learn to use the special equipment. In each of these three questionnaires, respondents used a five- or six-point scale to rate dimensions of interest. The other two questionnaires were projective in nature and required participants to estimate the time and type of training needed during future fielding of the CITV and CCD. Training questionnaires were designed for completion by Co Cdrs, Plt Ldrs, and TCs and provided opportunities to respond with written comments. For participants in the M1 Baseline condition, only a tailored version of the general training evaluation questionnaire was pertinent, because the remaining questionnaires focused on aspects of the CVCC equipment. Details of the training questionnaires, including copies of the actual instruments, can be found in Atwood et al. (1991).

SMI questionnaires. A set of SMI questionnaires was developed to assess perceptions of the new equipment by inquiring about operability and usefulness, strengths and weaknesses, and suggestions for improvement. These questionnaires were designed for CVCC participants and afforded the opportunity to write open-ended comments. Four SMI questionnaires were developed: two for vehicle commanders, addressing the CCD and CITV separately; one for gunners; and one for drivers. Each focused on design characteristics that might enhance or degrade mission performance. In each questionnaire, participants used a five-point scale to rate a series of statements about equipment functionality. Details of the SMI questionnaires, including copies of the actual instruments, can be found in Ainslie et al. (1991).

Researcher logs. Observation logs were developed for use by RAs working in simulators and by ECR staff working at PVD stations. RA logs focused on vehicle commander actions and served a variety of purposes. The primary purpose was to collect in-simulator data that could serve as back-up for the automated data collection system should a failure occur. Thus, questions concerning the frequency of equipment use predominated. Also included in the logs were RA assessments of crew coordination, the vehicle commander's allocation of time across available visual display media, and overall equipment proficiency.

PVD logs served to capture information in the ECR regarding voice radio communications and movement. This information enabled linkage of automated data with tactical events, and it also generated primary measures of performance. There were both

offensive and defensive test scenario logs for each PVD station (company and battalion). These logs were structured to facilitate recording of the following types of events associated with execution of test scenarios: (1) significant vehicle or unit movement events (e.g., crossing phase lines, entering mine fields); (2) voice communications (content); (3) starting and ending points (for phases, scheduled breaks, and equipment breakdowns); (4) fratricide firings; and (5) significant incidents (e.g., equipment problems, departures from the schedule). Appendix B includes a copy of a PVD log.

Map plot exercises. To provide a global index of a vehicle commander's general level of awareness in assessing the battlefield situation, end-of-phase map plot procedures were developed. Related to situational awareness techniques pioneered by Endsley (1988), these procedures called for the vehicle commander to plot representative tactical features on a blank map of the battlefield, based on his recollection of events during the just-completed phase. The tactical features included one's own terminal vehicle location, battle positions, minefields, and other graphic control measures. One map plot package was assembled for each phase which began with a FRAGO. Appendix B contains a copy of a representative package.

Procedures

This subsection details the methods and procedures used to implement the evaluation. The presentation is organized around training of participants, testing (scenario execution), data collection, and data reduction and analysis.

Training and Testing Schedule

The basic schedule for training and testing each group of participants spanned Monday through Thursday, with Friday serving as a back-up day. A depiction of the schedule for the CVCC condition appears in Figure 9. The schedule for the M1 Baseline condition (Figure 10) was adjusted to reflect the elimination of CCD and CITV training requirements; at the same time, a block of SIMNET navigation training was added. The first two and one half days (two days for M1 Baseline) comprised the training phase, in which participants received individual, crew, and unit training in a progressive manner. Unit training included exercises at both the platoon and company levels.

Test exercises were scheduled so that only one occurred on a given day, in order to avoid fatigue or carryover effects. When delays prevented conducting the first test exercise on Wednesday afternoon, the schedule was adjusted to accommodate the two test exercises on Thursday and Friday, respectively. This occurred frequently.

Throughout all phases of training and testing, a given crew was assigned to the same simulator. No exchange of positions within a crew was allowed. The RAs rotated across crews such

that one RA trained a crew (through company training), another conducted diagnostic testing, and a third monitored the crew during testing.

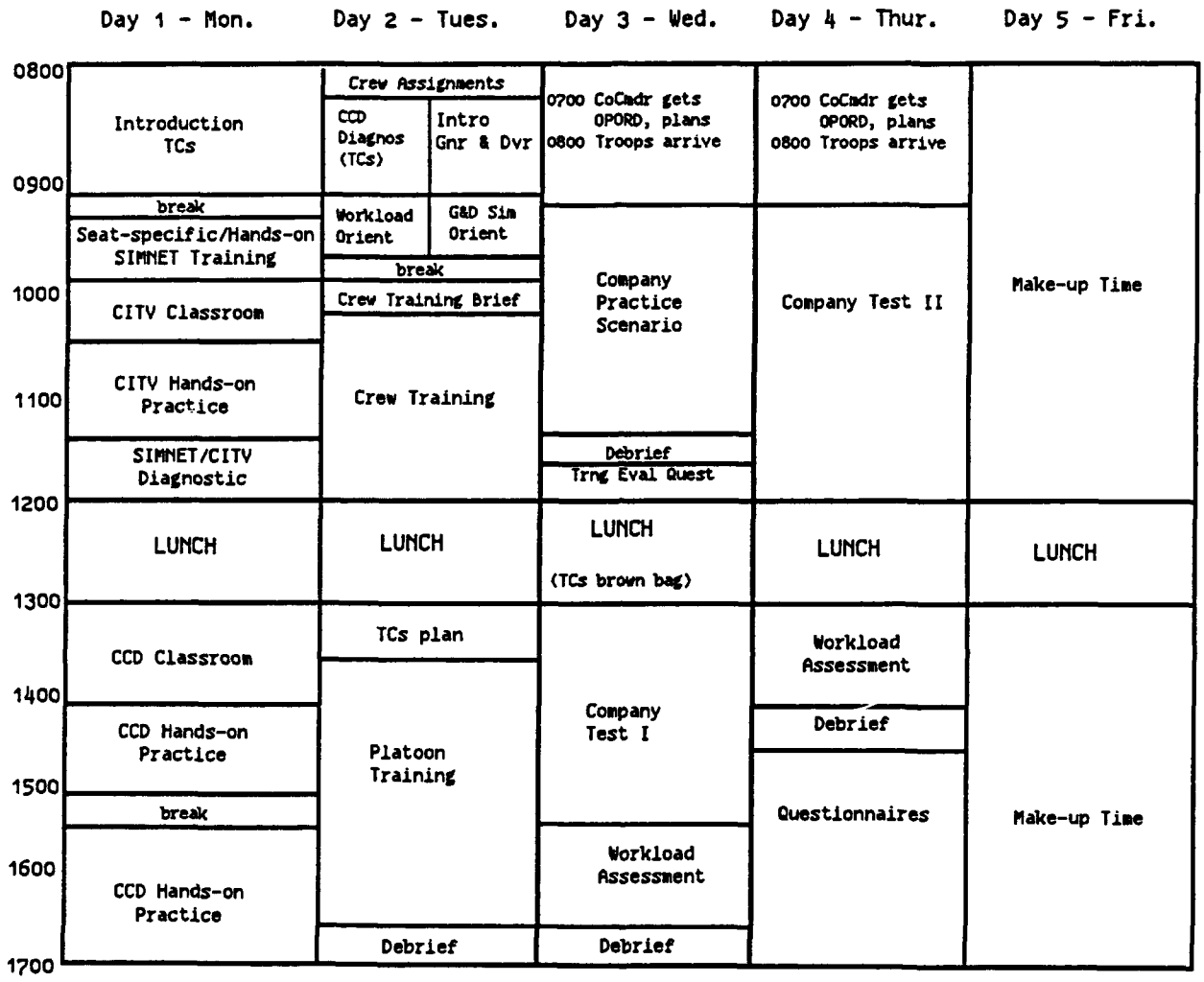

Figure 9. Block representation of the weekly training and testing schedule for participants in the CVCC condition.

Training of Participants

Training of participants was designed to familiarize crewmembers thoroughly with the special equipment involved, develop basic operational skills (including tactical applications of the equipment), and prepare the company for executing test scenarios. A combination of individual, crew, and unit training methods was developed to form a systematic, progressive training sequence. Somewhat different training programs were required for CVCC and M1 Baseline participants, given the CITV and CCD training requirements for the former. In addition, in both

conditions training was more extensive for vehicle commanders than for gunners and drivers. However, these differences applied only during individual training; once crew-level training began, training program differences disappeared. The scheduling of specific training sessions can be seen in Figures 9 and 10 for the CVCC and M1 Baseline conditions, respectively.

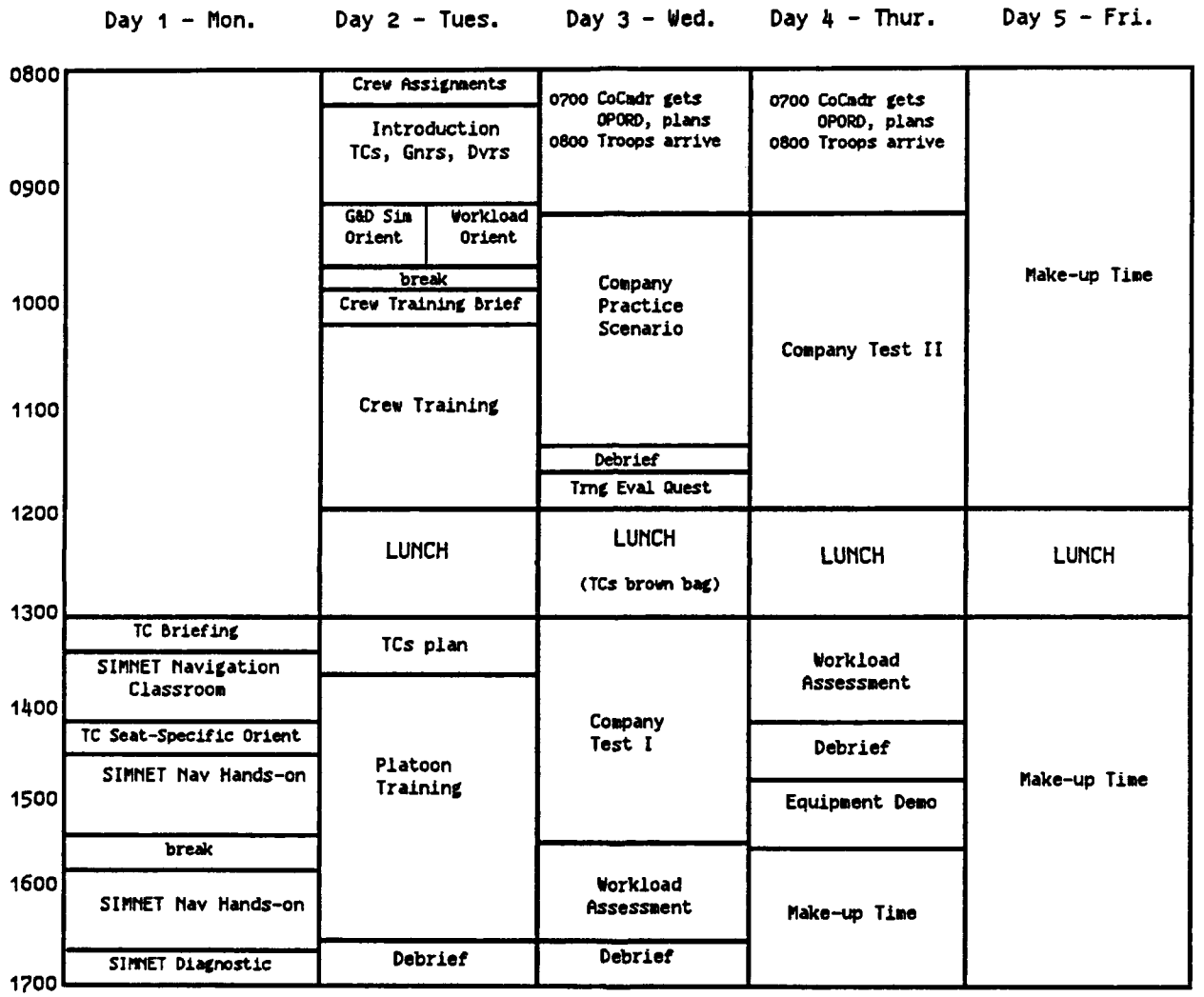

Figure 10. Block representation of the weekly training and testing schedule for participants in the M1 Baseline condition. (Training began on Monday afternoon.)

Individual training (CVCC condition). Individual training of vehicle commanders in the CVCC condition began on Monday morning with an overview briefing explaining the purpose and general methods of the evaluation. This was presented by the Battle Master. The Test Director also discussed issues affecting data collection, emphasizing the importance of conscientious role-playing by each participant. A classroom presentation by

the Assistant Battle Master then introduced the CCTB M1 simulator. Following this, RAs conducted one-on-one hands-on training in the simulators using seat-specific guides. This session focused on the vehicle commander's workstation, highlighting equipment differences between the simulator and a real M1 and introducing the CITV and CCD. Each vehicle commander performed selected tasks plus a few practice exercises at the end.

Following a short break, the vehicle commanders returned to the classroom for a viewgraph-assisted lecture on the CITV, presented by the RA Coordinator. An explanation of the hunter-killer concept was followed by a description of each CITV feature and function. Suggestions for tactical applications, such as selecting Autoscan sectors depending on one's position in the platoon and using Target Stack to pinpoint expected enemy avenues of advance, concluded the presentation. RAs then conducted hands-on CITV training in the simulators, during which explanations of features and functions alternated with practice by the vehicle commander. A scripted set of practice exercises ended the session, with the RA allowing the vehicle commander to do as much as possible on his own before prompting. By the end of this session, the vehicle commander had performed most functions three times.

At the end of the morning, RAs administered the SIMNET and CITV diagnostic tests. Each RA tested a different vehicle commander than she/he had trained. The RA emphasized to the vehicle commander that the diagnostics were not given to judge or score his individual performance. For each diagnostic, the RA read a given task, then compared the vehicle commander's performance to the correct sequence of steps written on the RA's form, and finally marked a "Go" if the vehicle commander performed the task correctly within the allotted time (1.5 minutes per task). At the end of the test the RA informed the vehicle commander of the outcome for each task and conducted retraining on those tasks he had performed incorrectly.

Training of the vehicle commanders on the CCD began in the afternoon with a classroom lecture on the purpose, development, features, and potential tactical uses of the CCD. The RAs then conducted hands-on training in the simulators using the same approach as in the CITV hands-on session--alternating explanation with practice and ending with a fixed set of practice exercises. To ensure adequate training with the large number of tasks involved, the hands-on session lasted the rest of the afternoon (3 hours) with a 15-minute break at the approximate mid-point. The following morning, the CCD diagnostic test was administered in the same fashion used for the earlier diagnostics. Remedial training was provided, as necessary.

Training of the gunners and drivers began on Tuesday morning with the same project overview briefing and CCTB orientation delivered earlier to the vehicle commanders. Following this classroom session, the RAs conducted seat-specific training: one

RA trained a group of three or four gunners (or drivers) using the appropriate seat-specific guides. While each participant had a chance to practice selected tasks, there were no practice exercises at the end of the session.

Individual training (M1 Baseline condition). During weeks in which the M1 Baseline was the test condition, individual training of vehicle commanders began in the afternoon on Monday with a statement of the purpose of the evaluation. (The standard overview briefing was presented to the entire group of participants on Tuesday morning.) Immediately following was the simulator orientation in the classroom, tailored appropriately to the simulator configuration lacking CITV and CCD functions.

The vehicle commanders then received special training in SIMNET navigation to compensate for the lack of automated navigation aids. This training started in the classroom with a viewgraph-assisted lecture on using the SIMNET map with protractor and land navigation methods of dead reckoning, terrain association, resection, and polar plotting. This instruction included practice exercises with the SIMNET map.

Upon completing the classroom session, the vehicle commanders were paired up for seat-specific orientation and navigation training in the simulators, conducted in hands-on mode by the RAs. While one of the pair drove the tank, the other occupied the vehicle commander's crewstation and practiced navigating while using the SIMNET map, protractor, and distance scale. This exercise involved following a cross-country route from one checkpoint to the next. The task structure required the vehicle commander to determine his location at several points using resection or polar plotting, and to use his grid azimuth indicator to determine what terrain feature or object lay along a given azimuth. At the end of an hour (sufficient for navigating three or four checkpoints), the participants changed positions so the second could complete his portion of the navigation exercise. During this entire session, an RA in the simulator delivered instructions for certain tasks, provided guidance to ensure proper use of techniques, and answered questions from the vehicle commander. At the end of the afternoon the RAs administered the same SIMNET diagnostic as was used with the CVCC vehicle commanders, with the addition of an extra question addressing the odometer.

Training of the M1 Baseline gunners and drivers began on Tuesday morning, when they received the full project overview briefing together with the vehicle commanders. Following this, the gunners and drivers received their simulator orientation and hands-on seat-specific training sessions, which were comparable to the corresponding sessions for the CVCC gunners and drivers except for minor tailoring to match the M1 Baseline configuration.

Crew training. After individual task training was complete, all collective task training was conducted in the same manner

regardless of condition. Crew training provided the first opportunity for the members of each tank crew to work together as a team. Consuming the last half of Tuesday morning, this session utilized a "sandbox" terrain setting: each crew navigated a six-waypoint route laid out within a 4-5 km by 4-5 km terrain square. Vehicle commanders in the CVCC condition used the CCD in creating routes and sending waypoints to the driver, while M1 Baseline vehicle commanders used the same navigation techniques practiced the day before.

Stationary gunnery targets appeared on the terrain to trigger target engagement and generate CONTACT and SPOT reports. The vehicle commanders were instructed to send limited types of reports based on events encountered during the exercise. For transmitting reports, vehicle commanders in the CVCC condition used their CCD, while M1 Baseline vehicle commanders used their voice radio. Vehicle commanders communicated directly with the exercise controller, bypassing normal unit communication channels. When a crew completed the first route, its simulator was reinitialized in a new sandbox so a second route could be negotiated. When time permitted, a crew was set up to run a third sandbox route. This training session lasted approximately an hour and a half.

Inside each simulator, an RA observed crew performance and reminded crewmembers to utilize fully all available equipment. The RAs used checklists itemizing specific equipment functions to help keep track of vehicle commander performance and ensure prompting when the vehicle commander overlooked or ignored a function. They freely provided guidance to the crewmembers and answered their questions.

Platoon training. Tuesday afternoon the platoon training exercise began. This training focused on mission performance at the platoon level as a stepping stone to company level operations. The Battle Master initiated the exercise by briefing the mission to the Co Cdr, using the company OPORD and graphic overlay materials (company operations overlay and fire support overlay). A copy of each was provided to the Co Cdr. After the Co Cdr backbriefed the Battle Master to ensure he understood the mission, he began the unit's planning and preparation process by briefing his Plt Ldrs. After demonstrating their understanding of the mission, they designated responsibilities for preparing working copies of the overlays. The 2d Plt Ldr also briefed his three TCs on the mission.

After approximately 45 minutes of planning and preparation, the unit moved to the simulators for final preparations lasting twenty minutes. This stage included checking the equipment, including radio nets; final navigation planning; intra-crew coordination; and pre-movement unit coordination. Vehicle commanders in the CVCC condition could create routes on their CCDs and send initial waypoints to their drivers. They also posted to their CCD tactical map the digital operations overlay. When the Co Cdr reported "REDCON-1" (Readiness Condition 1,

signalling all vehicles were ready to execute the mission), the Battle Master issued the order to begin executing the mission.

The platoon training scenario included both offensive and defensive tactical components, with two changes in mission scripted. The scenario began with an offensive phase, followed by a defensive phase; an offensive phase ended this training session. The complete scenario required approximately two hours to execute, not counting pre-movement planning and preparation. Two 15-minute breaks between phases were scheduled. FRAGOs began each follow-on phase, delivered by voice radio (M1 Baseline condition) or by digital burst plus voice radio supplement (CVCC condition). Vehicle commanders communicated via standard unit radio channels, with radio nets set in the tactically normal configuration (Figure 6). ECR staff included the Battle Master, Assistant Battle Master, and SAFOR operator.

This training scenario included both gunnery targets and OPFOR vehicles/units to set the stage for engagements and stimulate submission of reports. Vehicle commanders were to transmit the full range of reports, in keeping with the tactical flow of the scenario.

The RA Coordinator supervised the activities of the RAs, who served inside the simulators as instructors, prompters, monitors, and redistributors of ammunition. The RA Coordinator also responded to equipment problems, summoning a technician if necessary. The RAs used training checklists again during this exercise.

When the last scripted event of the scenario was complete, the Assistant Battle Master terminated the exercise. At this point the participants returned to the classroom for a debriefing, where they received feedback from the Battle Master or Assistant Battle Master on their mission performance.

Company training. The finale of the training program was the company training exercise, scheduled on Wednesday morning. The scenario for this exercise included an offensive (attack) phase, a delay phase with a displacement, and a defense phase. The initial mission briefing, planning, and preparation activities were very similar to those during the platoon training exercise, except that the time allotted for these activities was now 1.5 hours. The 20-minute pre-movement preparation in the simulators remained the same, as did the sequence for initiating mission execution. Approximately 2.5 hours were required to complete the entire scenario, not counting two 15-minute breaks separating phases.

In addition to the company OPORD, a battalion/task force OPORD was used for mission briefing and planning. Instead of company overlays, battalion/task force level overlays were used. One FRAGO for the two follow-on phases served to specify the new mission parameters. In the M1 Baseline condition, the FRAGO was delivered to the Co Cdr completely via voice radio, including the

locations for graphic control measures. In the CVCC condition, the basic FRAGO (including the new graphic overlay) was transmitted to the Co Cdr via digital burst from the ECR at the start of the second phase. To compensate for the limited text capacity (51 characters) of the digital FRAGO, a voice radio supplement followed the digital transmission. All vehicle commanders in both conditions were expected to update their paper map overlays with the new FRAGO information. In-simulator planning followed receipt of the FRAGO, at the end of which the Co Cdr reported "REDCON-1" and the Battle Master ordered execution to begin.

In addition to their secondary roles as battalion commander and battalion executive officer, respectively, the Battle Master and Assistant Battle Master role-played other key positions, including other Co Cdrs and scout unit commanders. The SAFOR operator played the roles of TCs assigned to the 1st and 3d Platoons, particularly the Plt Sgts. In discharging these roles, the ECR personnel interacted with the Co Cdr (or Plt Ldrs) by maintaining operational realism in line with conventional armor practice. On occasion the Battle Master or Assistant Battle Master provided corrective input to the Co Cdr in response to one or more elements of the company being lost or disoriented. However, this was done only after the ECR staff was convinced that conventional means (radio information or direct observation) would have reasonably indicated to the battalion staff that a problem existed.

As in the platoon training exercise, both gunnery targets and OPFOR units provided opportunities for engagement and submission of reports. Rules contained in the company SOP specified the parameters for transmitting reports.

Under the supervision of the RA Coordinator the RAs performed the same roles in the simulators as during the platoon exercise, again using a training checklist. Additional responsibilities during the company training scenario included administering map plot exercises (practice only) and copying map overlays. Both of these activities occurred at the end of follow-on phases.

When the last scripted scenario event was complete, or at a tactically feasible break point falling between 2.5 and 2.75 hours of scenario execution, the Battle Master declared an end to the exercise. All participants then returned to the classroom for a debriefing, where the Battle Master provided feedback on the company's mission performance. Participants' comments and suggestions were transcribed by a research team member.

Testing Procedures

The testing stage of this evaluation consisted of the execution of the two test scenarios--one offensive in nature, one defensive. Detailed materials for these scenarios appear in Appendix A. The same implementation procedures were used for

both scenarios. These procedures were developed and refined over the course of training of control personnel as well as pilot testing.

Execution of the scenarios provided the primary source of data, both automated and manual. To control for possible sequential effects, the order of the two scenarios was counterbalanced across the units in each condition. No more than one test scenario occurred on a given day. Every attempt was made to complete a scenario in a single morning or afternoon; an occasional morning scenario was continued into the afternoon after a lunch break, but no scenario was continued overnight.

In contrast to training exercises, the role of each RA during test scenarios was strictly to collect observational data and monitor equipment status. The RA was instructed not to coach or respond to questions with technical or tactical information.

Unit planning procedures. The orders brief for a test scenario was started two hours prior to the time scheduled for the start of scenario execution. This brief was conducted by the Battle Master role playing the task force commander. At the start of the orders brief the Co Cdr was provided with a copy of the battalion order, the operations and fire support overlays, a map, map case, and marking pens. The entire order was briefed in detail with the aid of maps, overlays, and view-graphs. At the conclusion of the orders brief the Co Cdr was given the opportunity to ask questions concerning the order, the operation, or his unit's specific tasks. All questions were discussed prior to continuing.

The Co Cdr was then provided a copy of the company order his unit would execute during the test scenario. After a thorough review questions were again discussed. At the conclusion of the orders brief the Co Cdr received a schedule of critical times (movement to simulators, REDCON-1 time, execution start time, etc.) and a time check to ensure synchronization with the control staff.

At ninety minutes prior to execution start time the Plt Ldrs and TCs received the company orders brief. Each Plt Ldr and TC was provided with a map, map case, and marking pens. The Co Cdr was provided with view-graphs to assist him in conducting the briefing. The remaining crew members (drivers and gunners) arrived one hour prior to execution start time to receive mission briefs.

As discussed earlier in describing scenario materials, the orders were designed to minimize decision making on the part of the Co Cdr and Plt Ldrs. This was necessary to eliminate the confounding influence of experienced versus inexperienced planners, which could have overshadowed comparisons of new versus existing technologies in terms of C^3 effectiveness. As a result, the unit's planning process focused on implementing the mission, rather than developing tactical options and deciding among them.

Unit preparation procedures. The Assistant Battle Master initialized the seven manned simulators using computerized MCC and SCC files. These files ensured consistent unit organization, terrain placement, and vehicle locations for each scenario.

The unit was moved to the simulators thirty minutes prior to execution start time. Pre-operations checks at all positions (driver, gunner, vehicle commander) ensured that simulators were operationally ready. Vehicle commanders signed on the platoon, company, and battalion radio nets, as appropriate. In the CVCC condition, vehicle commanders checked to ensure tactical map graphics were properly oriented, identified their own position and the position of their wing tanks, and established waypoints and routes. At ten minutes prior to execution start time the Co Cdr provided the Battle Master with a REDCON-1 report.

Execution procedures. Control personnel used standard methods, techniques, and decision rules in executing scenarios. This helped ensure that performance could be compared fairly across different units participating in the evaluation.

The Battle Master utilized the battalion PVD to monitor the activities of both the friendly and enemy forces. Offensive phases began with the unit's lead element crossing the line of departure (LD). Defensive phases began ten minutes after the Co Cdr reported REDCON-1. The Battle Master initiated certain events (e.g., movement of OPFOR vehicles, firing of enemy artillery) based on the specifications in the scenario events lists (Appendix A) and on friendly vehicles' locations with respect to overlay control measures or enemy vehicles. Scripted messages, required in all phases of both test scenarios, were initiated based on a unit's location on the battlefield. This procedure ensured all units received the same amount of information at essentially equivalent points in the scenario, regardless of variation in unit movement speed, maneuver techniques, or route specifics. It enabled the control staff to use an identifiable benchmark for executing each scripted action. The PVDs provided the Battle Master and the Assistant Battle Master with the information (unit location) required to prepare for and alert other ECR staff to an impending scenario event.

The Assistant Battle Master also used the battalion PVD to "flag" significant events as the test company maneuvered and fought to accomplish its mission. A "flag" was a digital event marker inserted in the DataLogger data stream, used later to key on significant events during data reduction. The company PVD was used to "flag" and record significant events of the platoons and the individual simulators during the course of the mission.

The SAFOR workstation enabled a single operator to control all BLUFOR and OPFOR, including maneuver and fire support elements. Display screens permitted the operator to monitor the battlefield from a bird's eye view. Configuration files standardized number and types of vehicles, unit configurations, unit placements, movement and firing parameters, and competence

levels for each scenario. The SAFOR operator controlled the timing of SAFOR activities during each scenario, based on actions of the manned units and guidance from the Battle Master. He used the two platoon radio nets to interact with the 1st and 3d Plt Ldrs when role playing their TCs. In addition, SAFOR software generated reports attributed to the semiautomated vehicles tethered to the 1st and 3d Plt Ldrs. These computer-generated reports included CONTACT, SPOT, and SHELL reports created when criterion events (e.g., enemy vehicle visible within a range of 2 km) occurred.

SAFOR fire initiation procedures. SAFOR elements were capable of delivering direct fires and indirect fires. Direct fire initiation parameters (maximum range and firing effect) for OPFOR and BLUFOR were established in the SAFOR initialization files. Maximum ranges were based on U.S. Army field manuals or discussions with SMEs. Maximum ranges for OPFOR tanks and infantry fighting vehicles were established at 2000 m and 1800 m, respectively. BLUFOR ranges for M1 tanks and M2 infantry fighting vehicles were set at 2500 m and 1800 m, respectively. Firing effect parameters for all SAFOR vehicles, both BLUFOR and OPFOR, were set at "novice," corresponding to a modest level of gunnery experience and effectiveness.

Enemy indirect fires were initiated based on the test company's location on the battlefield and whether or not it was within the line of sight of an OPFOR unit. Line of sight was determined by means of an intervisibility function available on the PVD. Based on the line of sight determination, the Battle Master directed the initiation of indirect fires on the test company. Indirect fires were delivered by means of the "bomb button" function at the SAFOR terminals. Indirect fires continued to fall on the test unit, in six to eight round volleys, until the test unit moved out of visual range of the OPFOR unit or the OPFOR unit was destroyed.

Out of sector procedures. Test vehicles that strayed out of sector were brought back into sector through role playing by the Battle Master, who observed vehicle locations and sector boundaries on the PVD display. If a unit strayed outside its assigned sector, the Battle Master acting as the battalion commander (or the Assistant Battle Master acting as the battalion S3) contacted the Co Cdr and reported that an adjacent unit had reported unidentified vehicles moving in its sector (the approximate number, location, and direction of movement were provided). The Battle Master directed the Co Cdr to check the location of his elements and report back with the results of his inquiry. This process continued until the stray elements were back within sector and the Co Cdr indicated they were under control. Similar procedures were followed when the Battle Master judged manned simulators were lost or disoriented, usually indicated by erratic movement or prolonged periods without movement at an inappropriate point. The control staff exercised as much tactical realism as possible in implementing these procedures.

Contingency procedures. Problems with simulator hardware or software, radio communications, SAFOR control, and availability of participants occurred occasionally. To enable consistent handling of such problems, a set of rules was developed to guide the decision process of the Test Director, in consultation with the research staff. In weighing alternative courses of action, the Test Director considered the impact on three primary factors: (a) quality and completeness of data, (b) command and control dynamics among the unit leaders, and (c) realistic execution of the scenario. In general, the options available to resolve problems included delaying the start of a phase, suspending execution of a phase already underway, dropping a crew to accommodate a disabled simulator, and moving crews to protect critical positions. The option with the least disruptive overall impact was normally the preferred course of action.

Whenever a problem occurred, a description of the problem and its resolution was noted on the PVD logs to ensure appropriate adjustments could be made later during data analysis and interpretation. If the problem occurred during the execution of a phase, PVD flags were sent to mark the start and end of the affected period. When the resolution impacted assigned crew positions and/or operating procedures, the Co Cdr was thoroughly briefed on the modifications.

When an equipment breakdown forced execution of the mission to be suspended, crews were moved from the simulators to the break area until the problem could be fixed. Once the problem was resolved, the crews returned to the simulators, conducted abbreviated pre-operational checks, formulated a REDCON-1 report, and resumed the mission.

When the Test Director determined that a problem with one simulator did not warrant suspending mission execution, the mission continued while the "down" simulator was repaired. The crew normally remained in the simulator and was integrated back into the mission as soon as possible.

End of phase procedures. At the end of each phase of a scenario the Co Cdr was required to provide the Battle Master with a complete SITREP (situation report) in the proper format. This procedure was followed to ensure that (a) the report was later available as a source of data and (b) the Co Cdr accounted for all of his elements. The latter facilitated the execution of the next phase by providing the Co Cdr with an update of his unit's status and location.

A 15-minute scheduled break separated phases within a scenario. Participants spent this time in one of the break areas, not being allowed to receive information about the next phase.

When the last scripted scenario event was complete, or at a tactically feasible break point falling between 2.5 and 2.75 hours of scenario execution, the Battle Master declared an end to

the test exercise. All participants then returned to the classroom for a debriefing, where the Battle Master provided feedback on the company's mission performance and asked questions about equipment utilization.

Data Collection Procedures

Automated data collection. Collection of automated data occurred during test scenarios and was handled by employees of Bolt Beranek and Newman Inc. (BBN), the site operations contractor, with input by PVD operators. Standard DataLogger procedures were employed. All test exercises were recorded on magnetic tape for subsequent reduction and analysis. A standard character string served to identify uniquely each scenario. Operators at both PVD stations (battalion and company) entered "flags" (digital event markers) corresponding to key tactical and administrative events. These events included starting and ending points (for each phase and significant equipment breakdown), significant vehicle/unit movement events (e.g., crossing the LD), and all voice messages transmitted on the battalion and company radio nets. Accompanying these flags were notes on the PVD log recording the flag number and the nature of the event or the content of the message. The flags and notes were used later to break scenario recordings into discrete phases and adjust for unscheduled breaks. PVD logs also served as important sources of data during manual data reduction.

Manual data collection. The primary research team members participating in manual data collection included the PVD operators and the RAs. They used a variety of manual instruments: paper-and-pencil questionnaires addressing biographical, training, and SMI issues; observation logs for both PVD operators and RAs; and map plot packages requiring recall of tactical features. Questionnaires and map plots were completed by participants.

Working generally with the vehicle commanders or the gunners and drivers in a group setting, research team members administered the various questionnaires at designated points during training and testing (Table 11). All participants completed the Biographical questionnaire; only vehicle commanders completed the remaining questionnaires, except for the Gunner's Evaluation and the Driver's Evaluation. For each training and SMI questionnaire, the administrator read a standard set of instructions tailored to the specific questionnaire. Participants were allowed as much time as needed to complete each questionnaire. SIMNET training questionnaires were scheduled for completion following the company training exercise for two reasons: to capitalize on recency of training experience and to reduce the volume of questionnaires following completion of the second test scenario. When schedule constraints on Wednesday morning prevented administering these questionnaires as planned, their administration followed the end of the second test scenario, coming before the SMI questionnaires.

Table 11

Questionnaire Administration Schedule

Questionnaire	Time of Administration
A. Biographical questionnaire	During overview briefing
B. SIMNET training questionnaires	
1. Training Evaluation	After company training
2. Ease of Learning	After company training
3. Training Time Needed	After company training
C. New equipment training questionnaires	
1. Type of Training Required	After SMI questionnaires
2. Time to Train	After SMI questionnaires
D. Soldier-machine interface questionnaires	
1. CITV Evaluation	After test scenario 2
2. CCD Evaluation	After test scenario 2
3. Gunner's Evaluation	After test scenario 2
4. Driver's Evaluation	After test scenario 2

RA logs were completed during each test scenario, based on the RA's observations of various aspects of the vehicle commander's behavior--equipment operation, radio communications, use of paper map and visual display devices, and interactions among crewmembers. The RAs recorded their observations and judgments on a paper copy of the log, attempting to stay as current as possible. They were careful to advise the vehicle commanders that the log was not being used to test or score their performance.

Operators at each PVD station recorded key information about scenario execution on a paper copy of the PVD log, which was tailored to a given PVD station and scenario. The movement, communications and other events recorded on the PVD log were discussed earlier in conjunction with embedding flags in automated recordings. The Assistant Battle Master manned the battalion PVD station and recorded log entries regarding company movement and battalion radio net traffic. Platoon movement events and company radio net messages were recorded at the company PVD station manned by two PVD operators. One of these operators recorded entries in that station's log, while the other handled the sending of flags. During each test scenario the operator recorded her/his observations based on (1) the continuous picture of the battlefield provided by the PVD display screen and (2) voice radio traffic. Unexpected events were recorded in open comment sections of the log. The company PVD

log recorder made notes about equipment problems and breakdowns, as well as other significant incidents (e.g., adjustments necessitated by missing participants).

Map plot packages were administered to vehicle commanders during both test scenarios. At the end of each FRAGO-based phase, the RA escorted the vehicle commander out of the simulator, removed the paper map from his possession, and handed him a map plot package, which the vehicle commander read and completed on his own. The RA allowed a maximum of 5 minutes for this task, during which the vehicle commander was not permitted to use the CCD, paper map, or other vehicle commanders as resources.

Following completion of the map plot exercise, the RA carried the paper map to a photocopy machine and copied the portion of the overlay pertaining to the FRAGO just completed. She or he also copied the grid reference cross-hairs to document the alignment of the overlay with the SIMNET map. The RA recorded identifying information on the back of the overlay copy and, as time permitted, transferred significant notes made on the overlay by the vehicle commander.

During the debriefings following the platoon and company training exercises and each test scenario, comments and suggestions by the participants were transcribed by a research team member.

Structuring the Database

The data collection activities generated a large volume of raw data. To structure the database for suitable analysis and interpretation, a set of quantitative measures was developed and organized within eight functional categories. These categories were: mission performance, information acquisition and communication, tactical assessment and planning, operational control of the unit, positioning and navigation, target acquisition and engagement, CCD usage, and CITV usage. The development of these categories and accompanying measures is described in the next chapter. Appendix C contains operational definitions for the complete set of measures.

Data Reduction and Analysis Procedures

To protect the privacy of individual soldiers, a unique number was assigned to each participant at the start of the week. This number was used in place of the individual's name on all data collection instruments, except for the Biographical questionnaire. This numbering system served to identify individual cases in all database activities.

Reduction and analysis of data proceeded through four more or less distinct steps: database management (data entry and quality control), data reduction, descriptive analyses, and inferential analyses. The first two steps of this sequence were

tailored for automated and manual data, respectively. Each step is summarized below.

Database management. Creation of the database organizing the manually collected data began with the establishment of a set of dBASE III PLUS[4] files, one file per manual data collection instrument (e.g., officer's Biographical questionnaire). Under the supervision of the data analysis specialist, RAs entered data into these files using data entry screens on a microprocessor with keyboard. The data so entered were printed out and verified (100 percent) against the original data collection forms. This verification (quality control, or QC) was accomplished by one or two RAs who had not entered the data. As an added measure, the data analysis specialist performed spot checks of verified data files.

In the case of automated data collected by DataLogger, database creation was performed by BBN personnel using a VAX computer. DataProbe extracted raw data from magnetic tapes recorded during test scenarios, while RS/1 organized the resulting data into files. Research team members reviewed printouts of these files to check for out-of-range or inconsistent data. These files were intermediate only, providing input to the data reduction process described in the following section.

Data reduction. A number of measures required hands-on processing of manually collected data (e.g., counts of voice radio messages, scoring of situational awareness map plots). For each measure in this category, the data analysis coordinator developed data reduction forms with instructions guiding the data reducer carefully through each step. RAs performed the manual data reduction operations, after receiving training in the procedures from the RA Coordinator. The latter closely supervised the RAs during these activities, remaining physically nearby to answer questions and verifying the work on a spot-check basis. When the data reduction forms were complete, an RA entered key data directly from the forms into dBase files. To facilitate this, the data to be entered were highlighted on the data reduction form. The resulting computer files were verified (100 percent QC) by RAs.

Reduction of automated data was performed by BBN personnel. In this process, data elements from the intermediate files established during creation of the automated database were combined computationally by RS/1 to produce specified measures. Frequently the data elements did not require computation to generate measures. Throughout the reduction of the automated database, extensive effort was invested to ensure the accuracy and quality of the constituent data. The end product of this lengthy process was a set of eight consolidated files containing DataLogger-based data from all nine weeks of the evaluation.

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[4]dBASE III PLUS is a trademark of Ashton-Tate.

Descriptive analyses. Prior to analyzing manual and automated data, procedures were developed for handling missing and contaminated data. Missing data resulted from a unit's failure to complete the third phase, equipment failures, and participant absences. In addition, sometimes a participant skipped an occasional question on a questionnaire. Contaminated data resulted generally from equipment malfunctions. The general rule for handling both missing and contaminated data was to omit the affected measures from analyses. Only those contaminated measures/values feasibly influenced by the unplanned event were omitted. All data excluded from analyses were treated as simple missing cases, with no values being estimated by cell means, grand means, etc. In addition to missing cases, some measures were dependent on conditional events for individual values. For example, a vehicle commander who did not receive an AMMUNITION status report had no opportunity to relay that type of report. The outcome of these combined factors was variability of cell sample sizes across phases and measures.

Most measures produced a single value per phase for each vehicle commander/crew or company. A few, however, produced multiple values for a given vehicle commander/crew or company. For example, each SHELL report recorded during a phase generated a report accuracy score. For such measures, when multiple values occurred they were combined by averaging to form a single value for analysis purposes.

The Statistical Package for the Social Sciences for the IBM Personal Computer (SPSS/PC+[5]) was used for all data analyses. The REPORT procedure was used for computing means, medians, and standard deviations. The CROSSTABS procedure was used for generating frequency distributions, including percent response breakouts for questionnaire items.

Inferential analyses. The sizable number of measures generated a large set of potential inferential analyses to probe for significant effects. In order to reduce the total number of analyses, the bulk of the measures were tested for simple effects of condition using Phase II data from each scenario. SPSS' DSCRIMINANT procedure was used to generate univariate F-ratios for these purposes. Those measures which did not differentiate significantly between conditions were generally not subjected to further analysis.

The measures which remained after this screening were entered into parametric analyses of the independent variables. Where feasible, related measures were grouped appropriately for MANOVA analysis. Otherwise, univariate ANOVA procedures served to analyze individual measures. These analyses were performed using SPSS' MANOVA (Multivariate Analysis of Variance) procedure, which includes provisions for univariate ANOVA, testing of

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[5]SPSS/PC+ is a trademark of SPSS Inc.

underlying assumptions, comparisons among individual means, and related capabilities.

The principal independent variables guiding the analysis of data were condition, a between-subjects variable with two levels (CVCC and M1 Baseline), and phase, a repeated-measures variable. While each scenario contained three scripted phases, only the CVCC companies were consistently able to complete the third phase within the available time. This made it difficult to compare the two conditions on Phase III performance. As a result, only Phases I and II were generally used in analyzing and presenting the data. The within-subjects variable associated with echelon was relevant primarily to CVCC-unique measures and was employed principally in analyzing equipment usage data (Ainslie et al., 1991).

In interpreting the statistical analysis outcomes, a probability level of .05 or less was required before an effect was considered statistically significant. The large number of MANOVA and ANOVA analyses raised the overall error level beyond the nominal .05 level. However, in practical terms this was offset somewhat by the reduced statistical power associated with the small sample sizes.

Development of Measures

Approach

A key component of the evaluation was the development of a variety of measures of performance. This development effort emphasized objective parameters useful for quantifying company, platoon, and crew performance. While the ultimate goal was to enable conclusions regarding specific issues, the importance of maintaining realistic connections with current tactical doctrine was also clear. This section traces the logic and the process followed in developing a comprehensive set of quantitative measures.

Providing the overall structure organizing the development of measures were three classes of performance: mission performance, tactical performance, and equipment usage. Mission performance encompassed broad aspects of mission accomplishment. At a finer level, tactical performance spanned a wide range of crew and unit activities involved in executing the mission. The class of equipment usage indicators was important in documenting the contributions of the CVCC experimental configuration to tactical and mission performance.

In terms of approach, the principal strategy was to balance candidate measures available from automated and manual data collection sources against doctrinal constructs for classifying battlefield activities. In identifying candidate measures, those used in earlier CCTB research (especially Du Bois and Smith, 1989; 1990) were evaluated for suitability. At the same time, ARI input was weighed and existing analytical capabilities of the DCA system were inventoried. These efforts resulted in a master list consisting mostly of automated measures whose feasibility was already established. At this point the list was loosely organized on the basis of functional commonality or task relatedness.

The next step was to sort the candidate measures according to the three classes of performance. Those measures dealing with mission completion as well as overall kills and losses were placed in the mission performance class. Measures of primary value in quantifying equipment usage, especially in an SMI context, were grouped in one of two categories: CCD usage and CITV usage. This left a large set of measures falling in the tactical performance class, which would have been unwieldy without further organization.

Providing a doctrinal basis for structuring the tactical performance measures was the Blueprint of the Battlefield (Department of the Army, 1989b). An integrated reflection of current warfighting principles, the Blueprint of the Battlefield provides a systematic framework for organizing tactical unit activities. The framework consists of seven battlefield operating systems (BOS), each of which encompasses a family of related functions required for effective combat operations. For

example, the Maneuver BOS includes three major categories--move, engage the enemy, and control terrain. The framework progresses to increasingly finer levels of detail, until activities such as "initiate mounted movement" are inventoried. For the simulation scenarios developed for this evaluation, two BOS are pertinent: the Maneuver BOS and the Command and Control BOS. Table 12 outlines the structure of these two BOS at a global level.

Table 12

Battlefield Operating Systems Used for Organizing Tactical Performance Measures

I. Maneuver BOS
A. Move: position forces, navigate, negotiate terrain
B. Engage the enemy: employ direct and indirect fire
C. Control terrain: occupy terrain, control through fire
II. Command and Control BOS
A. Acquire and communicate information: receive, transmit, and maintain information
B. Assess the situation: review current situation, determine need for action
C. Determine action: develop/analyze/select courses of action
D. Direct and lead subordinate forces: prepare and issue orders, provide command presence

Source: Blueprint of the Battlefield (Department of the Army, 1989b).

In line with the pertinent BOS, the following activities were common to all phases within the two test scenarios: (a) conduct mounted movement; (b) navigate; (c) acquire targets; (d) engage direct fire and indirect fire targets; (e) receive and transmit information about enemy and friendly elements; (f) receive and transmit missions; (g) evaluate incoming information; (h) select courses of action; and (i) issue orders. These defined the domain of expected performance for the units participating in this evaluation. On balance, each activity appearing in Table 12 was represented in the domain except for controlling terrain.

These activities were reviewed in the context of the nature of the candidate measures. The focus of this step was to establish an appropriate and workable set of categories, with reasonable balance across categories and at least modest depth within. Where appropriate, closely related types of activities were combined; for example, unit movement and navigation were merged to form a single category. The resulting set of organizing categories numbered five: information acquisition and communication; tactical assessment and planning; operational

control of the unit; unit positioning and navigation; and target acquisition and engagement.

Capping this stage was the sorting of candidate measures of tactical performance among the five organizing categories. This proceeded on the basis of "most logical fit." When a given measure could apply to two or more categories, it was generally placed in the one with the strongest connection. This was not intended to preclude a measure from contributing analytical information to other categories during data analysis and interpretation. Occasionally, a new measure was added to fill an apparent void or provide a more complete picture. During this process, reviews by ARI staff members provided opportunities for input.

In its final form, the aggregate collection of categories for organizing measures included the following: one encompassing mission performance, five related to tactical performance, and two dealing with equipment usage. Table 13 lists these categories.

Table 13

List of Measurement Categories

I. Mission performance
II. Tactical performance
A. Information acquisition and communication
B. Tactical assessment and planning
C. Operational control of the unit
D. Unit positioning and navigation
E. Target acquisition and engagement
III. Equipment usage
A. CCD usage
B. CITV usage

Operationalization of Measures

The foregoing efforts resulted in a large set of candidate measures organized in eight primary categories. The remainder of the basic development activities involved operationalizing these measures, inspecting sample data, refining the set of measures and its organization, and verifying final computational procedures. In operationalizing and refining the measures, several key principles guided the development work. Because the evaluation focused on the armor company, operational measures representing company performance were emphasized. In practice, this was accomplished by selecting (a) parameters which were the product of company-wide integration, most often with the Co Cdr as the final integrator (e.g., CALL FOR FIRE reports), or (b)

data elements which could be combined easily to represent the entire company. To capitalize on the multiple performance opportunities built into each scenario, the individual phase served as the basic timeframe for quantifying performance. This principle was designed to yield at least one observation per phase for each measure, rather than a single observation per scenario.

To the maximum extent possible, operationalization of measures relied on automated data elements. The reasons for this were to reduce the requirements for manual data reduction and to minimize the opportunities for human error. Minimizing redundancy among measures within and across categories was a major objective of this stage. When feasible and appropriate, measures were normalized by using percent (e.g., percentage of enemy vehicles destroyed, percentage of mission time a vehicle spent at halt) as the unit of measure. Because of the standard structure and implementation rules defining each phase, it was frequently appropriate to express measures relying on a counting procedure (e.g., number of reports sent) as raw counts. However, a few count-based measures were converted to "per hour" units when opportunities for occurrence were more closely linked to the passage of time than to scenario structure. Such was the case with the frequency of resetting Autoscan parameters and the frequency of lasing.

It was necessary to develop detailed computational rules for measures involving automated data elements. Elapsed time and time-in-state measures required careful specification of start and end points for timing operations. Counting time-sensitive events necessitated designation of time "windows" within which to confine counting operations. For example, the vehicle commander's Designation of a target was inferred to have prompted a firing event only if the firing occurred within 15 sec of the Target Designate event. In another example, multiple adjustments of the CITV Autoscan sweep rate were taken to be part of a single reset operation unless they were separated by more than 30 sec. SME input was incorporated into the development of these computational rules.

Occasional measures required the integration of multiple data elements (automated and/or manual) to implement a complex construct. A good example of such measures was accuracy of reports, which relied on determining the correctness of key information (e.g., location of enemy vehicles) reported by vehicle commanders. The multiple data elements, or components, needed to determine correctness typically involved diverse measurement scales with different units of measure. For these measures, scoring procedures (criteria, or rules) were developed to assign points to component data elements. In effect, these scoring procedures transformed divergent scales into common metrics. The assignment of points was an arbitrary process, but consistency among similar components and relative weighting among the different components of a given measure were prime considerations. A combination of manually and automatically

recorded data elements normally contributed to each criterion-based measure, with a component score being determined by assigning points to the data element according to the scoring rules. The total value for a given measure was computed by simply adding its component scores. Because of the unique characteristics of the two test scenarios and the phases within each, it was sometimes necessary to develop scoring procedures tailored to each phase. Wherever possible, scales for a given measure were kept constant across phases.

Closely related to measures based on criterion scoring was a small set of higher-order measures referred to as composites. Whereas criterion measures combined information concerning a single attribute (e.g., accuracy of reports), composite measures integrated different types of information (e.g., accuracy and timeliness; enemy killed together with friendly losses). Thus, these more complex measures represented an aggregation of elemental constructs, crossing boundaries which would normally separate different types of information. The principles for developing scoring procedures for composite measures were very similar to those followed with criterion measures. Component elements were identified and then point assignment rules were devised for each component. Consistency of scale range across phases and scenarios was a key goal. The differences among scenarios and phases generally necessitated specialized scoring procedures for each phase. The research team's C^2 SME participated integrally throughout these development acitivities.

Once the initial set of operational definitions was complete, the associated computational procedures were applied to sample data from the movement to contact scenario completed by the second group of CVCC participants. Individual distributions from the resulting analyses were inspected with an eye to statistical properties and interpretability. This review process led to modifications in the operational procedures for some measures, combining of some measures, elimination of a few, and moving some from one category to another. The research staff then applied the revised set of operational procedures to the same set of sample data and reviewed the resulting distributions. Additional revisions and verification were necessary for selected measures, at the end of which all operational procedures were finalized.

Description of Basic Measures

Across the eight measurement categories there were nearly ninety basic measures. Some of these actually consisted of a set of sub-measures; for example, percent of CCD reports relayed was computed for each of ten types of reports. Many of the measures based on automated reports were computed in this manner. As a somewhat different example of sub-measures, the percent of the time the vehicle commander used his different CCD map scale functions was computed for each of the four map scales available.

The complete set of measures contained three types of variables: direct derivatives based on data elements recorded automatically or manually, criterion-based measures combining closely related data elements, and composites integrating different types of data elements. As measurement variables, the derivative measures retained or reflected the characteristics of their underlying measurement scales. This group included event counts, counts converted to proportions (percentages), cumulative times converted to percent of the mission duration, elapsed times (latencies), distances, velocities, and dispersion calculations. On the other hand, criterion and composite measures took on arbitrary scale values depending on the scoring procedures developed. The criterion scoring process transformed the component measurement scales into ordinal scales resulting from the assignment of points.

Of the total set of measures, more than three-fourths were based entirely on automated data elements. The remainder were based solely on manually collected data elements (e.g., PVD logs, RA logs) or on a combination of automated and manual data elements. The criterion-based measures and composite measures together accounted for half of the measures incorporating manual data elements.

A number of measures depended on data elements from the CCD or the CITV. Obviously it was not possible to obtain such measures for the M1 Baseline units. The two categories of measures quantifying CCD and CITV usage applied strictly to the CVCC condition. Most other categories contained some measures which were obtainable for only CVCC units, especially the category dealing with information acquisition and communication. No measures were unobtainable in the CVCC condition.

Appendix C presents definitions of all measures and describes the scoring procedures for criterion measures. A summary accounting of measures, organized by category, follows. The accounting indicates whether each measure applies to both conditions or only the CVCC condition.

Mission Performance

This category, quantifying overall performance in each phase, contained eight measures (Table 14) ranging from the number of phases completed during a scenario to time to loss of mission effectiveness. The latter measure was defined in terms of the point in the phase when six of the test company's thirteen vehicles had been destroyed. This was taken as the point beyond which the unit would have been unable to effectively continue its mission. While this is perhaps a generous definition, it is consistent with current doctrine and contemporary experience at the NTC. Three of the measures, addressing friendly and enemy casualties, were shared with the target acquisition and engagement category. All measures in this category were available for both the CVCC and the M1 Baseline conditions.

Table 14

List of Mission Performance Measures

Number of phases completed	[CVCC, M1 Baseline]
Time to complete phase	[CVCC, M1 Baseline]
[a]Percent of enemy vehicles killed by BLUFOR	[CVCC, M1 Baseline]
[a]Percent of enemy kills by manned vehicles	[CVCC, M1 Baseline]
[a]Number of manned vehicle losses	[CVCC, M1 Baseline]
Number of tethered vehicle losses	[CVCC, M1 Baseline]
Number of losses per kill (manned vehicles)	[CVCC, M1 Baseline]
Time to loss of mission effectiveness	[CVCC, M1 Baseline]

[a]Used also in the target acquisition and engagement category.

Information Acquisition and Communication

Focusing heavily on the transmission and processing of reports, this category contained only derivative measures (Table 15). Named reports were those for which defined formats existed in the company SOP: CONTACT, CALL FOR FIRE, ADJUST FIRE, SPOT, SHELL, SITUATION, AMMUNITION, INTELLIGENCE, and NBC. Three of the measures, dealing with report accuracy, were shared with the tactical assessment and planning category. More than half of the measures, dependent on CCD features, applied only to CVCC units.

Table 15

List of Information Acquisition and Communication Measures

Number of named reports originated	[CVCC, M1 Baseline]
Number of voice radio messages, other than named reports	[CVCC, M1 Baseline]
Number of requests to clarify FRAGOs and INTEL reports	[CVCC, M1 Baseline]
[a]Accuracy of first CONTACT report (criterion)	[CVCC, M1 Baseline]
[a]Accuracy of SHELL reports (criterion)	[CVCC, M1 Baseline]
[a]Accuracy of CALL FOR FIRE reports (criterion)	[CVCC, M1 Baseline]
Percent of named reports transmitted by voice radio	[CVCC only]
Percent of received reports retrieved (overall and by report type)	[CVCC only]
Percent of received reports relayed	[CVCC only]
Median time to retrieve reports	[CVCC only]
Median time to relay reports	[CVCC only]
Median time to relay reports full net	[CVCC only]
Percent of time vehicle commander used vision blocks, GPSE, CITV, CCD map	[CVCC only]

[a]Used also in the tactical assessment and planning category.

Tactical Assessment and Planning

Representing the results of the unit's situation assessment and decision making, this category contained a predominance of criterion measures (Table 16). These measures focused on the effectiveness of processing tactical information and reaching selected tactical decisions, such as determining when and where to call for supporting artillery fires. Displacement range, quantifying the proximity of the nearest enemy vehicle at the time the Co Cdr ordered the first element to displace, applied only to the delay phase of the defensive scenario.

Table 16

List of Tactical Assessment and Planning Measures

Time taken by Co Cdr to process FRAGO	[CVCC, M1 Baseline]
Index for Co Cdr's FRAGO (composite)	[CVCC, M1 Baseline]
[a]Accuracy of first CONTACT report (criterion)	[CVCC, M1 Baseline]
Timeliness of first CONTACT report (criterion)	[CVCC, M1 Baseline]
Combined index for first CONTACT report (composite)	[CVCC, M1 Baseline]
[a]Accuracy of SHELL reports (criterion)	[CVCC, M1 Baseline]
[a]Accuracy of CALL FOR FIRE reports (criterion)	[CVCC, M1 Baseline]
SPOT report index (composite)	[CVCC, M1 Baseline]
Unit displacement range (delay phase only)	[CVCC, M1 Baseline]
Map plot index (criterion)	[CVCC, M1 Baseline]
Paper map overlay usage index (criterion)	[CVCC, M1 Baseline]

[a]Used also in the information acquisition and communication category.

Operational Control of the Unit

Dealing with tactical leadership activities of the Co Cdr and Plt Ldrs, this category contained measures (Table 17) based solely on automated data elements. These measures were selected or developed to represent leaders' efforts in directing and controlling subordinate elements' tactical execution. They ranged from direct constructs (e.g., digital dissemination of navigation information) to constructs related indirectly to directing/controlling activities. For example, direct firing by the Co Cdr and Plt Ldrs was expected to be less frequent because leadership task demands would compete with target acquisition and engagement. A group of criterion-based unit dispersion measures was developed in accordance with established doctrine (Department of the Army, 1985; 1987). These were designed to provide indicators of unit formation and movement discipline, reflecting to some extent the effectiveness of the leaders' operational control. Computation of dispersion was based on the distance

between the unit's center of mass and the most distant manned vehicle. Dispersion measures applied only to the offensive scenario, since tactical movement was very limited during defensive phases.

Table 17

List of Operational Control of Unit Measures

Percent of rounds fired by Co Cdr and Plt Ldrs	[CVCC, M1 Baseline]
Co Cdr's average distance from the company center of mass (offense only)	[CVCC, M1 Baseline]
Percent of time company dispersion exceeded 600 m (offense only)	[CVCC, M1 Baseline]
Percent of time 2d platoon dispersion exceeded 200 m (offense only)	[CVCC, M1 Baseline]
Percent of time company dispersion fell below 300 m (offense only)	[CVCC, M1 Baseline]
Percent of time 2d platoon dispersion fell below 100 m (offense only)	[CVCC, M1 Baseline]
Number of fratricide hits (manned vehicles)	[CVCC, M1 Baseline]
Number of fratricide kills (manned vehicles)	[CVCC, M1 Baseline]

Unit Positioning and Navigation

The measures in this category (Table 18) quantified key aspects of tactical movement, with navigation reflected indirectly in most of the measures. Primary movement parameters relating to velocity were based on instantaneous velocity values obtained every 30 sec. Travelling out of sector was tabulated from investigator observations recorded on the PVD Logs. Selected manual measures provided information about usage of the paper map and straying outside sector boundaries.

Table 18

List of Unit Positioning and Navigation Measures

Distance travelled	[CVCC, M1 Baseline]
Fuel used	[CVCC, M1 Baseline]
Mean velocity (while moving)	[CVCC, M1 Baseline]
Percent of time moving velocity exceeded 40 km/hr	[CVCC, M1 Baseline]
Percent of time at halt (offense only)	[CVCC, M1 Baseline]
Number of times manned vehicles travelled out of sector	[CVCC, M1 Baseline]

Target Acquisition and Engagement

Nearly all of the measures within this category (Table 19) dealt directly with target engagement; however, most of the measures spoke indirectly to target acquisition. Based solely on automated data elements, these measures focused on hits and kills inflicted on enemy vehicles. Two measures indexed the target engagement contributions of special CITV capabilities (Target Designation and Target Stacking), applicable only to CVCC units. A final measure monitored the direct risk involved in engaging the enemy, namely, receiving hits from enemy units. Three of the measures which quantified friendly and enemy losses were shared with the mission performance category.

Table 19

List of Target Acquisition and Engagement Measures

Maximum lasing range (vehicle-to-target)	[CVCC, M1 Baseline]
Median target hit range (vehicle-to-target)	[CVCC, M1 Baseline]
Percent of targets hit at ranges exceeding 2200 m	[CVCC, M1 Baseline]
Median target kill range (vehicle-to-target)	[CVCC, M1 Baseline]
Percent of targets killed at ranges exceeding 2200 m	[CVCC, M1 Baseline]
[a]Percent of enemy vehicles killed by BLUFOR	[CVCC, M1 Baseline]
[a]Percent of enemy kills by manned vehicles	[CVCC, M1 Baseline]
Number of targets hit using Target Designate	[CVCC only]
Number of targets hit using Target Stack	[CVCC only]
Number of hits taken by manned vehicles	[CVCC, M1 Baseline]
[a]Number of manned vehicle losses	[CVCC, M1 Baseline]

[a]Used also in the mission performance category.

CCD Usage

Relating most directly to SMI dimensions, the measures in this category (Table 20) quantified selected functions available while operating the CCD. The bulk of them dealt with map functions and report processing functions. Two measures indexed control inputs, while two were based on icons appearing on the tactical map. Most of these measures were normalized by computing percentage, per hour, or per report values. Based strictly on automated data elements, this category applied only to CVCC units.

Table 20

List of CCD Usage Measures

Percent of time each map scale was active	[CVCC only]
Percent of time each map scroll function was active	[CVCC only]
Percent of time each map feature was active	[CVCC only]
Percent of control inputs by touchscreen	[CVCC only]
Percent of grid inputs to reports via lasing	[CVCC only]
Number of CCD reports originated per hour	[CVCC only]
Percent of prepared reports eventually transmitted	[CVCC only]
Percent of reports retrieved, by source	[CVCC only]
Number of retrievals per report received	[CVCC only]
Median number of icons displayed on tactical map	[CVCC only]
Median number of icons posted to tactical map	[CVCC only]

CITV Usage

The measures in this category (Table 21) related most directly to SMI aspects, quantifying specific functions involved in operating the CITV. Based solely on automated data elements, these measures did not apply to M1 Baseline units. Basic CITV operating features received most of the focus in this category. Four of the measures dealt with the special target acquisition and management capabilities of the CITV, from the perspective of basic usage parameters. Many of the measures were normalized by computing values on a percentage or per hour basis.

Table 21

List of CITV Usage Measures

Percent of time in each operating mode	[CVCC only]
Percent of time in Black-hot and White-hot modes	[CVCC only]
Percent of time in 3X and 10X magnification modes	[CVCC only]
Number of times Autoscan sector limits were set per hour	[CVCC only]
Autoscan sector width, averaged across the phase	[CVCC only]
Number of times Autoscan rate was set per hour	[CVCC only]
Autoscan rate, averaged across the phase	[CVCC only]
Number of targets entered in Target Stack	[CVCC only]
Median time to fire after target was selected from Target Stack	[CVCC only]
Number of times a target was Designated	[CVCC only]
Median time to fire after target was Designated	[CVCC only]

Results and Discussion

This section presents and discusses the results of the evaluation related to soldier-in-the-loop performance issues. The presentation begins with general considerations, including a summary of the comparability of the samples representing the two conditions. The organization of data follows the basic research issues: (a) performing the mission, (b) acquiring and communicating information, (c) assessing the situation, (d) directing and leading the unit, (e) positioning and navigating, and (f) engaging the enemy. The next subsection presents CVCC-unique data stemming mainly from report handling capabilities of the automated C^3 equipment. The discussion concludes with a brief review of limitations of the findings and selected methodological implications.

The data in this report derive predominantly from automated measurement sources, consistent with the focus on tactical performance. For a complete account of the evaluation's findings and their implications, the reader is encouraged to review the entire family of reports. Atwood et al. (1991) document questionnaire results pertaining to training issues and implications, while Ainslie et al. (1991) present findings relating to SMI issues, including questionnaire-based data and equipment usage measures. Tactical and operational implications are discussed by Kerins and Leibrecht (in preparation). Summary data for the IVCC condition can be found in Appendix D.

Factorial analyses (ANOVAs and MANOVAs) will be represented by only summary information in this chapter; more detailed information in the form of MANOVA and ANOVA output tables can be found in Appendix E. Where simple F-values for condition were extracted from discriminant analyses, no summary tables are found in Appendix E.

To determine comparability of the CVCC and M1 Baseline participants, key factors from the Biographical questionnaire were analyzed (Appendix F). These included age, rank, education level, experience in armor, experience with the M1 tank, experience in combat maneuver (TO&E) units, SIMNET experience, and experience with computers. As appropriate, t-tests or chi square tests were used to compare the two groups on these factors. As expected, no significant differences between groups were found. The high degree of demographic comparability between the two groups of participants is the intended result of the randomization procedure used to assign test companies to either condition.

The presentation and discussion of performance measures follows, organized by research issue. Each subsection begins with a restatement of the basic issue along with delineation of hypotheses, then addresses the offensive scenario followed by the defensive scenario, and ends with general discussion, as appropriate. Where pertinent, participant comments are included.

Performing the Mission

Issue: What is the impact of the CVCC on overall mission performance?

The following expectations, or functional hypotheses, guided the analysis of overall mission performance:

1. The integrated capabilities of the CVCC would be expected to increase the speed of mission execution, particularly during offensive operations where tactical movement dominates.

2. The CVCC's enhanced features, especially related to target acquisition and management, should improve the unit's effectiveness in destroying the enemy.

3. The advantages of the integrated CVCC systems in gathering and disseminating information should enable greater survivability.

The measures addressing this category include: number of phases completed; time to complete each phase; percent of enemy vehicles killed; percent of total kills of enemy vehicles scored by manned vehicles; number of losses sustained by manned and tethered vehicles; and the losses per kill ratio for manned vehicles. Time to loss of mission effectiveness was omitted from the analysis because loss of six or more vehicles in a phase occurred infrequently. Data will be presented first for the offensive scenario, followed by data for the defensive scenario.

Offensive Scenario

Each of the five CVCC companies fully completed the three phases of the offensive scenario within the 2.5 hour time limit. However, three of the four M1 Baseline companies failed to complete the third phase within the allotted time. The number of phases completed by the M1 Baseline companies averaged 2.25, compared to a mean of 3.0 for the CVCC companies. These results relate directly to the time required to complete Phases I and II, displayed in Table 22. The CVCC companies took 31% less time to complete Phase I than did the M1 Baseline companies; the corresponding figure for Phase II was 36% less time in favor of the CVCC condition. An ANOVA (see Appendix E) on time to complete phase revealed the effect of condition to be significant ($F(1, 7) = 12.46$, $p = .01$), as was phase ($F(1, 7) = 332.2$, $p < .001$). The condition by phase interaction was not significant. The shorter times in Phase II were due to the shorter distance involved.

While the CVCC companies killed 30% more enemy vehicles than the M1 Baseline companies during the first offensive phase (Table 22), the difference disappeared during Phase II. The overall effect of condition was not significant for this measure ($F(1, 7) = 4.15$, $p = .08$), though the effect of phase was significant ($F(1, 7) = 8.74$, $p = .02$) as well as the condition by

phase interaction ($F(1, 7) = 5.74$, $p = .048$). It is possible that the smaller number of enemy vehicles encountered in Phase II did not provide a sufficient challenge in terms of target acquisition and engagement opportunities.

As seen in Table 22, engagement-based measures for the manned vehicles (percent of kills scored by manned vehicles, number of manned vehicle losses, and losses per kill ratio for manned vehicles) generally favored the CVCC condition. A MANOVA performed on these three variables together revealed no significant effect of condition (Pillai's Trace = .356, $p = .49$), although the phase effect was significant (Pillai's Trace = .968, $p < .001$). The condition by phase interaction was not significant. The higher losses for manned vehicles, compared to tethered (SAFOR) vehicles, is easily explained: protected by a "kill-suppress" feature, manned vehicles could cumulate losses and still continue the mission, whereas tethered vehicles could die only once. Losses taken by the tethered vehicles were infrequent and did not provide a sufficient basis for differentiating between conditions in the offensive scenario.

Table 22

Mission Performance Measures for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I n=5	Phase II n=5	Phase I n=4	Phase II n=4
Time to complete phase (in minutes)	62.0 (13.2)	34.9 (7.9)	89.6 (9.5)	54.8 (9.7)
% enemy vehicles killed	95.6 (4.6)	98.3 (3.7)	73.4 (21.7)	100 (0)
% kills by manned vehicles	32.1 (15.9)	79.6 (20.8)	32.1 (17.3)	63.7 (11.1)
# manned losses	2.80 (3.3)	.20 (.45)	4.75 (3.0)	1.50 (1.9)
# tethered losses	.60 (1.3)	0 (0)	.25 (.50)	.25 (.50)
Losses/kill, manned vehs	.38 (.47)	0 (0)	1.43 (2.4)	.06 (.11)

Defensive Scenario

In the defensive scenario, all five of the CVCC companies completed the three phases scripted within the 2.5 hour time limit. Of the four M1 Baseline companies, two failed to complete the third phase within the time allotted. The M1 Baseline units completed an average of 2.5 phases, compared to a mean of 3.0 for the CVCC units. There is a clear relationship between these results and the time taken to complete Phases I and II, figures for which appear in Table 23. The CVCC companies required 16% and 22% less time, respectively, to complete Phases I and II than did the M1 Baseline companies. An ANOVA on time to complete phase revealed the effect of condition was significant ($F(1, 7) = 6.66$, $p = .036$). Neither the phase effect nor the condition by phase interaction was significant.

The CVCC companies killed somewhat fewer enemy vehicles than the M1 Baseline companies during defensive Phases I and II (Table 23). While this trend was not significant ($F(1, 7) = 1.52$, $p = .26$), it bears comment. Phase I of the defensive scenario called for a unit displacement in response to superior enemy forces. The CVCC companies executed the displacement earlier, on the average, than the M1 Baseline companies; mean displacement range favored the former by more than 300 m (see Table 27). This afforded the CVCC units less opportunity to inflict kills on the enemy, since they remained directly engaged a shorter time. During the hold-in-place mission of Phase II, the percent of kills scored by manned vehicles was a more critical parameter. This measure (see Table 23) indicated the automated equipment conferred an advantage on the manned elements of the CVCC units during the second phase. However, this advantage was not significant (see next paragraph). Neither the effect of phase nor the condition by phase interaction for percent of enemy vehicles killed was significant.

Manned vehicle-based measures of target engagement favored the CVCC condition (Table 23). This was true for percent of kills scored by manned vehicles (Phase II only), number of manned vehicle losses, and losses per kill ratio for manned vehicles. The absence of this trend for percent of kills scored by manned vehicles in Phase I most likely relates to the earlier displacement by CVCC units, discussed in the preceding paragraph. These three variables were analyzed together in a MANOVA, revealing no significant effect of condition (Pillai's Trace = .458, $p = .34$), although the phase effect was significant (Pillai's Trace = .922, $p < .003$). The condition by phase interaction was not significant. Losses taken by the tethered vehicles were less frequent for the CVCC companies in both phases. This trend, however, was not significant.

Table 23

Mission Performance Measures for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I n=5	Phase II n=5	Phase I n=4	Phase II n=4
Time to complete phase (in minutes)	51.3 (7.6)	43.3 (8.8)	60.9 (8.1)	55.6 (11.5)
% enemy vehicles killed	56.9 (18.4)	73.3 (12.4)	71.6 (22.2)	81.0 (10.3)
% kills by manned vehicles	30.6 (11.6)	77.3 (14.7)	31.4 (7.7)	56.5 (7.1)
# manned losses	14.0 (9.5)	10.6 (7.2)	28.0 (15.0)	12.2 (6.2)
# tethered losses	2.0 (.71)	1.4 (1.7)	3.8 (1.5)	2.0 (.82)
Losses/kill, manned vehs	.70 (.28)	.83 (.58)	1.37 (.65)	1.14 (.54)

Summary of Findings

The hypothesized increase in speed of mission execution for CVCC companies was confirmed. The CVCC equipped units executed each phase in significantly less time than the M1 Baseline units, allowing them to complete more phases per scenario. These trends were true of both offensive and defensive phases. Similar results have been reported for platoons equipped with POSNAV (Du Bois & Smith, 1989) and for platoons equipped with IVIS (Du Bois & Smith, 1990).

The expected improvement in the CVCC units' effectiveness in destroying the enemy was not observed. It may well be that the CITV does not confer a clearcut advantage under all tactical conditions. At the same time, the structure of the test scenarios likely influenced these findings. In the offensive phases, companies in both conditions tended to achieve maximum scores, suggesting enemy targets were not sufficiently demanding. In the first defensive phase, CVCC companies executed a scripted displacement when enemy vehicles were further away, reducing opportunities to engage targets. Thus the test scenarios may not have afforded a robust opportunity to test effectiveness in destroying the enemy.

Although the mean values for manned vehicles in (a) losses and (b) losses per kill ratio supported the hypothesis of increased survival of CVCC equipped vehicles, the trends were not statistically significant. However, the trends were consistent across measures and across scenarios, providing an indication of what might be expected in future research.

Manned vehicles in both conditions sustained substantially more losses than their tethered counterparts. This was true of both types of scenarios. In part, this undoubtedly reflected the "kill-suppress" feature which protected manned vehicles from being functionally killed, even though the computer scored a hit as "destroyed." The invincibility of the manned vehicles may well have made their vehicle commanders less cautious in fighting the battle, especially since there was no loss of operational capabilities upon sustaining a killing hit. Future research employing kill suppress should provide clear feedback to crewmembers when their vehicle sustains what would be a killing hit.

Acquiring and Communicating Information

Issue: How does the CVCC impact the acquisition and communication of information?

Guiding the analysis of data related to acquisition and communication of information were three hypotheses:

1. The standardization and clarity afforded by CCD reports would be expected to reduce the volume of reports originated during tactical operations.

2. The integrated CVCC's enhanced information gathering capabilities, including the inputting of location grids by lasing or touching the tactical map, are expected to enable more accurate messages.

3. The ability of the CVCC vehicle commander to read (and re-read) digital messages at his own pace, along with tactical map icons representing reports, should lead to fewer questions about reports received. The re-read capability, together with the digital overlay accompanying FRAGO text, should reduce the frequency of questions concerning FRAGOs.

The measures bearing on this category include: number of named reports originated; number of "other" (non-named) radio messages transmitted; accuracy of CONTACT, SHELL, and CALL FOR FIRE reports (shared with the tactical assessment and planning category); number of requests to clarify FRAGOs and INTELLIGENCE reports; and percent of named reports transmitted by voice radio (CVCC only). Report accuracy measures are based on criterion scoring of "what" and "where" elements (see Appendix C for scoring rules). CVCC-unique measures (e.g., measures pertaining to retrieval of digital reports) are addressed in a later subsection.

To understand the CVCC results dealing with communications, a clear appreciation of the radio net structure used in this evaluation and the routing arrangements governing transmission of digital burst reports is essential. The structure of the battalion, company, and platoon nets in relation to test company vehicles can be found in Figure 6. The Co Cdr and Plt Ldrs could originate and relay digital reports on two nets; the Plt Sgt and wingmen had access to only their platoon net. For the Co Cdr and Plt Ldrs, the default net for FRAGOs and INTELLIGENCE reports was the downward-going net. For all other reports the default was the upward-going net. All stations on a given net received every report transmitted on the net, even if a single station was the truly intended receiver. For example, if the 1st Plt Ldr sent a SPOT report to the Co Cdr (on the company net), the 2d and 3d Plt Ldrs also received the report. They could then relay the report downward, upward, or both directions at once. Each vehicle commander's CCD, then, typically held a sizable collection of digital reports which included those originated by that vehicle commander plus reports transmitted by other vehicle commanders sharing his radio nets.

Offensive Scenario

Table 24 presents results for the measures from the offensive scenario, organized by condition and phase. The number of named reports (CONTACT, SPOT, CALL FOR FIRE, ADJUST FIRE, SHELL, AMMUNITION, SITUATION, and NBC--all upward-going) originated by the CVCC Co Cdr and Plt Ldrs corresponded quite closely to the reports which would follow doctrinally from the events scripted in each phase of the scenario. It is important to note that no relayed reports were included in the number of digital reports originated.

In Phase I, the CVCC Co Cdr and Plt Ldrs originated fewer named reports, transmitted by both digital burst and voice radio, than their counterparts in the M1 Baseline condition, who transmitted reports strictly by voice radio. This difference disappeared in Phase II. The effect of condition was not significant (see following paragraph). The CVCC Co Cdr and Plt Ldrs transmitted the greatest share of their named reports via digital burst, averaging 80% in Phase I and 71% in Phase II.

In transmitting voice radio messages (other than named reports), CVCC Co Cdrs and Plt Ldrs each originated fewer messages than their M1 Baseline counterparts in Phases I and II. This trend suggests more comprehensive or accurate transmission of information in digital reports and/or greater radio discipline among the CVCC units. A MANOVA performed on both named and other reports together revealed no significant effect of condition; the effect of phase was significant (Pillai's Trace = .500, $p < .001$), but the condition by phase interaction was not. Considering the similarity of the phase effect for the CVCC and M1 Baseline conditions, it most likely resulted from differences between Phases I and II in tactical opportunities for report generation.

Measures of report accuracy indicated a CVCC equipment advantage for CONTACT and CALL FOR FIRE reports, but not for SHELL reports. The effect of condition was significant for CONTACT report accuracy ($F(1, 7) = 117.4$, $p < .001$) but not CALL FOR FIRE or SHELL report accuracy. The lack of a CVCC advantage in the case of SHELL report accuracy may be understandable, given that lasing--the CVCC's most accurate means of inputting grid coordinates to reports--was not very useful with transient shell impacts. However, it is not clear why being able to obtain location inputs by touching the tactical map did not appear to improve accuracy of SHELL reports. For none of these three measures was the effect of phase or the condition by phase interaction significant.

Table 24

Information Acquisition and Communication Measures (Co Cdr and Plt Ldrs) for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I	Phase II	Phase I	Phase II
# named rpts originated	5.55 (4.37) n=20	3.70 (1.66) n=20	8.12 (4.50) n=16	3.56 (2.13) n=16
# "other" radio msgs	1.15 (1.69) n=20	3.85 (3.77) n=20	3.19 (4.61) n=16	4.94 (5.04) n=16
CONTACT rpt accuracy (Max = 5)	5.00 (0) [100%] n=5	4.80 (.45) [96%] n=5	1.50 (1.73) [30%] n=4	.75 (1.50) [15%] n=4
SHELL rpt accuracy (Max = 3)	.61 (.44) [20%] n=5	1.08 (1.32) [44%] n=4	.92 (1.07) [31%] n=4	.83 (.76) [28%] n=3
CALL FOR FIRE accuracy (Max = 5)	2.38 (2.06) [48%] n=4	2.06 (1.87) [41%] n=3	1.50 (2.12) [30%] n=2	0 (0) [0%] n=1
# requests to clarify FRAGOs and INTEL rpts	.20 (.45) n=5	.40 (.55) n=5	2.25 (1.26) n=4	4.00 (1.63) n=4

Note: Figures in brackets express means as a percent of the maximum possible score.

Radio messages seeking clarifying information were quantified by tabulating the number of requests to clarify FRAGOs and INTELLIGENCE reports, summed across the Co Cdr and Plt Ldrs. Substantially greater numbers of clarification requests occurred among M1 Baseline units (Table 24), suggesting less clarity of communications relying strictly on voice radio. This trend was significant, as documented by a significant effect of condition ($F(1, 7) = 21.91$, $p = .002$).

Defensive Scenario

As in the offensive scenario, the number of named reports originated by the CVCC Co Cdr and Plt Ldrs (Table 25) in the defensive scenario corresponded quite closely to the events scripted in each phase. The CVCC Co Cdr and Plt Ldrs transmitted the greatest share of their named reports via digital burst, averaging 71% in Phase I and 87% in Phase II.

In originating both named reports and voice radio messages other than named reports, CVCC Co Cdrs and Plt Ldrs sent nearly the same number of messages as their M1 Baseline counterparts in Phases I and II. A MANOVA performed on both measures together revealed the effect of condition was not significant; the effect of phase reached significance (Pillai's Trace = .216, $p < .018$), but the condition by phase interaction did not. As in the offensive scenario, the phase effect most likely reflected structural differences between Phases I and II.

Parallelling the offensive scenario, the CVCC equipment conferred an advantage on the accuracy of CONTACT and CALL FOR FIRE reports, but not SHELL reports. The effect of condition was significant for CONTACT report accuracy ($F(1, 7) = 11.0$, $p = .01$) but not CALL FOR FIRE or SHELL report accuracy. Neither the phase effect nor the condition by phase interaction was significant for any of these measures.

The number of requests to clarify FRAGOs and INTELLIGENCE reports, summed across the Co Cdr and Plt Ldrs, can be seen in Table 25. Substantially fewer numbers of clarification requests occurred among CVCC units, suggesting greater clarity of communications relying on digital messages. However, the effect of condition was not significant.

Summary of Findings

The hypothesized decrease in volume of reports originated by CVCC vehicle commanders was not observed. The number of named reports originated during each phase was consistent with the tactical events in each scenario which could be expected to prompt reports. However, the report volume measure was defined such that fragmented transmissions of a report and repeated transmissions of the same report were not counted. Had each discrete transmission been quantified, a difference in favor of the CVCC condition may well have resulted. This point merits investigation in future research.

Table 25

Information Acquisition and Communication Measures (Co Cdr and Plt Ldrs) for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC Phase I	CVCC Phase II	M1 Baseline Phase I	M1 Baseline Phase II
# named rpts originated	7.00 (5.86) n=20	5.40 (4.06) n=20	6.19 (3.47) n=16	4.38 (3.69) n=16
# "other" radio msgs	2.15 (3.32) n=20	1.10 (1.21) n=20	2.44 (2.56) n=16	1.31 (1.35) n=16
CONTACT rpt accuracy (Max = 5)	4.00 (2.24) [80%] n=5	2.80 (2.59) [56%] n=5	0 (0) [0%] n=4	1.25 (2.50) [25%] n=4
SHELL rpt accuracy (Max = 3)	.59 (.37) [20%] n=5	.57 (.56) [19%] n=5	.96 (.82) [32%] n=4	.50 (.58) [17%] n=4
CALL FOR FIRE accuracy (Max = 5)	2.30 (1.82) [46%] n=4	2.87 (1.20) [57%] n=5	.83 (1.04) [17%] n=3	0 (0) [0%] n=1
# requests to clarify FRAGOs and INTEL rpts	0 (0) n=5	1.80 (1.30) n=5	1.00 (1.41) n=4	4.50 (2.52) n=4

Note: Figures in brackets express means as a percent of the maximum possible score.

Previous research (e.g., Du Bois & Smith, 1990) has reported relatively high volumes of digital report transmissions. However, these previous figures have included repeat transmissions and relays of reports received from others, in addition to originating transmissions. The number of named reports originated has not been quantified in previous CVCC/CCTB research.

Overall, the CVCC Co Cdrs and Plts Ldrs transmitted approximately one-fifth of their named reports by voice radio, even though they were instructed to use the CCD for such reports. This occurred during both offensive and defensive phases. In verbal comments, the participants often stated it took too long

to prepare reports, especially CONTACT and SHELL reports. The usefulness of the CCD in preparing and sending reports appears to depend somewhat on the type of report, the operational situation (compare demands during an engagement versus a consolidation phase), and the need for immediacy.

The expectation of improved accuracy of digital reports received limited support. Of three report types examined (CONTACT, CALL FOR FIRE, and SHELL), only CONTACT report accuracy was significantly better in the digital mode.

The hypothesized reduction in the number of queries needed to clarify digital reports received support from offensive scenario data. The number of requests to clarify FRAGOs and INTELLIGENCE reports exhibited a significant difference in favor of the CVCC condition during movement to contact phases. The mean differences during the defensive phases also favored the CVCC units but did not reach statistical significance.

Assessing the Situation

Issue: What is the effect of the CVCC on tactical situation assessments by tank commanders?

The analysis of data pertaining to assessing the tactical situation was guided by four functional hypotheses:

1. The CVCC's enhanced features, including the tactical map with digital overlays and digital report capabilities, are expected to enable faster in-vehicle assessment and planning in response to changes in mission.

2. The enhanced information gathering capabilities of the CCD and CITV should enable more accurate tactical assessments, as reflected in digital reports.

3. The CVCC's advantages in gathering and disseminating information are expected to enhance the speed of reporting enemy contact.

4. The expanded information gathering and dissemination capabilities of the CVCC equipment should improve the vehicle commander's overall awareness of the battlefield situation.

The measures relevant to this category include: time for the Co Cdr to process FRAGOs; composite index for the Co Cdr's FRAGOs; accuracy of CONTACT, SHELL, and CALL FOR FIRE reports (shared with the information acquisition and communication category); timeliness of CONTACT reports; unit displacement range (defensive scenario only); and the map plot index. The accuracy, timeliness, and composite index measures for selected reports are criterion measures, as is the map plot index. The scoring rules for these criterion measures can be found in Appendix C. The composite CONTACT report index was dropped from the analysis because it added little to the component measures of accuracy and

timeliness of CONTACT reports. In addition, the composite SPOT report index was omitted due to methodological and interpretive difficulties.

Offensive Scenario

Table 26 displays summary data for the tactical assessment measures from the offensive scenario. Co Cdrs of CVCC units were able to process an incoming FRAGO and prepare to transmit it to their Plt Ldrs in less than half the time taken by their M1 Baseline counterparts. (The time was measured from the start of the Assistant Battle Master's voice radio transmission of the FRAGO to the start of the Co Cdr's voice radio transmission to his Plt Ldrs. The measure did not include the Co Cdr's actual transmission time, clarification interactions, or processing of FRAGOs by Plt Ldrs.) Statistically, however, the condition effect was not significant for time to process FRAGOs. A companion measure, the FRAGO index (Table 26), integrated both completeness of content and speed of initiating unit movement, reflecting the Co Cdr's responsivity in implementing combat directives. Although the FRAGO index showed a mean difference favoring the CVCC equipment, the condition effect was not significant.

Measures of report accuracy indicated a CVCC equipment advantage for CONTACT and CALL FOR FIRE reports, significant only in the case of CONTACT reports (see preceding subsection on acquiring and communicating information). Since assessment of battlefield events is involved in preparing those reports, the improved report accuracy suggests the tactical assessments themselves were more accurate, at least for CONTACT reports.

Overall, timeliness of CONTACT reports (time from first CONTACT report transmission to first firing of the engagement) was enhanced by the CVCC equipment, with a significant condition effect ($F(1, 6) = 6.86$, $p = .04$). The effect of phase was not significant, although the condition by phase interaction was significant ($F(1, 6) = 12.0$, $p = .013$).

Also presented in Table 26 is the map plot index. Using criterion scoring procedures (Appendix C), this index quantified error in plotting from recall selected tactical map features (e.g., phase line, minefield location). The mean for the M1 Baseline condition was significantly higher than that for the CVCC condition ($F(1, 61) = 9.63$, $p = .003$). M1 Baseline vehicle commanders had only their paper map with overlay available for graphic representation of the battlefield. They typically made notes about key events or information on the overlay itself, including updated operations overlay information received in voice radio FRAGOs. This contrasted dramatically with the CVCC vehicle commanders, who could rely on their CCD tactical map to automatically track key information and display new digital overlays received with FRAGOs. Thus, the M1 Baseline vehicle commanders processed map-related information more actively than their CVCC counterparts, as documented by the paper map overlay

Table 26

Tactical Assessment Measures for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC Phase I	CVCC Phase II	M1 Baseline Phase I	M1 Baseline Phase II
Time to process FRAGO (Co Cdr) (in minutes)	---	2.46 (4.43) n=5	---	5.72 (2.72) n=4
FRAGO index (Co Cdr) (Max = 17)	---	9.60 (.55) [56%] n=5	---	6.75 (3.10) [40%] n=4
CONTACT rpt timeliness (Max = 3)	2.40 (.89) [80%] n=5	.40 (.55) [13%] n=5	0 (0) [0%] n=3	.50 (1.00) [17%] n=4
Map plot index (Max = 6)	---	1.40 (1.19) n=35	---	2.75 (2.20) n=28

Note: Figures in brackets express means as a percent of the maximum possible score.

usage index (CVCC mean = .09; M1 Baseline mean = 2.89). Whether the CVCC vehicle commanders became overly reliant on their automated map is difficult to tell, because map recall does not necessarily indicate current awareness.

Defensive Scenario

Table 27 presents tactical assessment and planning data for the defensive scenario. As in the offensive scenario, the Co Cdr's FRAGO processing time and his FRAGO index both showed an advantage for the CVCC condition. The condition effect was not significant for FRAGO processing time ($F(1, 7) = 4.11$, $p = .08$), although the mean difference was relatively large. The CVCC equipment clearly enhanced FRAGO accuracy and timeliness, with a significant condition effect for the FRAGO index ($F(1, 7) = 12.6$, $p = .009$).

In parallel with corresponding trends seen in the offensive scenario, report accuracy measures indicated a CVCC equipment advantage for CONTACT and CALL FOR FIRE reports. As was presented in the preceding subsection on acquiring and communicating information, the advantage was significant only for CONTACT reports.

In Phase I of the defensive scenario, the Co Cdr was instructed to displace from the starting battle position when the enemy approached within 1800 m. The effectiveness of the company's assessment of the emerging tactical situation was reflected in the range at which the Co Cdr issued the order for the first element to displace. Values closer to 1800 m would represent better performance. On average, the CVCC equipment conferred a 300 m advantage in this situation. The effect of condition was significant ($F(1, 7) = 7.64$, $p = .028$).

The mean map plot index for the M1 Baseline condition (Table 27) was higher than that for the CVCC condition, although the condition effect was not significant ($F(1, 60) = 3.82$, $p = .06$). As discussed in the case of the offensive scenario, the more active use of the paper map in the M1 Baseline condition most likely accounted for this pattern.

Table 27

Tactical Assessment Measures for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC Phase I	CVCC Phase II	M1 Baseline Phase I	M1 Baseline Phase II
Time to process FRAGO (Co Cdr) (in minutes)	---	1.69 (1.38) n=5	---	10.20 (9.43) n=4
FRAGO index (Co Cdr) (Max = 16)	---	11.8 (1.48) [74%] n=5	---	8.25 (1.50) [52%] n=4
CONTACT rpt timeliness (Max = 3)	.20 (.45) [7%] n=5	0 (0) [0%] n=5	0 (0) [0%] n=4	0 (0) [0%] n=4
Unit displacement range (in meters)	1152.0 (208.6) n=5	---	848.8 (66.2) n=4	---
Map plot index (Max = 6)	---	1.59 (1.02) [26%] n=34	---	2.25 (1.62) [38%] n=28

Note: Figures in brackets express means as a percent of the maximum possible score.

Summary of Findings

The expected increase in speed of CVCC Co Cdrs' in-vehicle assessment and planning was confirmed statistically only for the FRAGO index during the defensive scenario. The trends favoring the CVCC condition were consistent across measures (both FRAGO processing time and FRAGO index) and across scenarios, but small sample sizes and large variability of data prevented all but the trend specified above from reaching statistical significance. Du Bois and Smith (1990) reported that IVIS-equipped Plt Ldrs took less time to plan FRAGOs than their no-IVIS counterparts. The current trends indicate that the CVCC enabled Co Cdrs to more quickly assess new mission requirements and ready the FRAGO for execution, but confirmation awaits future research. Digital FRAGOs (including standardized text and digital overlays) and CCD tactical map features were undoubtedly responsible for the observed trends.

The expectation of more accurate tactical assessments received moderate support. The significant improvement in CONTACT report accuracy in the digital mode indicated more accurate assessment of the evolving tactical situation. During the delay phase of the defensive scenario, CVCC equipped companies conducted the unit displacement in a more timely fashion than those lacking the automated equipment, indicating an improved capabilitiy to gauge the size and proximity of the threat forces.

The hypothesized increase in speed of CVCC units' reporting of enemy contact was confirmed in the offensive scenario. The CVCC's enhanced capabilities enabled units to transmit the first CONTACT report with significantly more lead time preceding the first firing of the engagement. This trend did not occur in the defensive scenario, where manned vehicles appeared to engage the larger enemy force with a greater sense of urgency ("fire now, report later").

The expectation that the CVCC's automated capabilities would enhance overall awareness of the battlefield situation was not confirmed. However, no direct measures of current awareness were employed. Although the CVCC vehicle commanders demonstrated significantly poorer map recall than their M1 Baseline counterparts, memory for map features does not directly reflect current awareness. Procedurally, the map plot instrument may have favored M1 Baseline commanders, who had only their paper map to rely on and therefore were more active in maintaining their map overlay. At the same time, map recall could be important when the CCD fails or when dismounted activities occur (e.g., sandtable exercises). A number of participants did voice concern that they might come to rely too heavily on the CCD tactical map. Future research on this issue should involve a broader range of measures of awareness.

Directing and Leading the Unit

Issue: What impact does the CVCC have on commanders' effectiveness in directing and leading subordinate forces?

Three functional hypotheses guided the analysis of data related to directing and leading the unit:

1. For CVCC vehicle commanders in leadership positions (Co Cdr and Plt Ldrs), the demands in using the CCD to execute their leadership responsibilities are expected to reduce their participation in target acquisition and engagement.

2. The integrated CVCC's automated features, especially the POSNAV capabilities, should allow the Co Cdr more flexibility in positioning his tank with respect to the rest of the company.

3. The enhanced capabilities afforded by the POSNAV functions and the CITV to monitor vehicle locations should enable greater flexibility of unit movement, as reflected in unit dispersion.

The measures dealing with operational control of the unit include: percent of manned vehicle rounds fired by the Co Cdr and Plt Ldr crews; Co Cdr's distance from the unit center of mass; percent of time company dispersion exceeded 600 m; percent of time 2d platoon dispersion exceeded 200 m; and percent of time 2d platoon dispersion fell below 100 m. The dispersion-related measures applied only to the offensive scenario, since the bulk of the defensive scenario was executed with tanks in fixed battle positions. Omitted from the analysis were the percent of the time company dispersion fell below 300 m and the number of fratricide hits and kills by manned vehicles, due to an excessive number of zero values in both cases.

Offensive Scenario

The measure, percent of rounds fired by the Co Cdr and Plt Ldr crews, was designed to indicate the relative level of firing activity, hypothesized to be reduced for CVCC equipped units because of increased attention to the CCD as a tool for executing leadership responsibilities. A value below the "even share" level (one-seventh, or 14.3%) would indicate relatively less involvement in target acquisition and engagement than for those vehicle commanders in non-leadership positions. In the offensive scenario, the mean percentages (Table 28) for the CVCC leaders were comparable to those for the M1 Baseline, leaders in both conditions being slightly above the "even share" level. The effect of condition was not significant. These findings suggest this parameter was not a sensitive indicator of controlling the unit. They further suggest that acquiring and destroying targets took priority at all echelons within the company during enemy engagements. The findings for use of visual devices across positions (see later subsection on CVCC-unique measures) clearly showed that use of the CCD increased as echelon increased. In

spite of vehicle commanders' occasional comments that using the CCD distracted them from fighting the battle, the objective findings indicate that was not the case.

The CVCC Co Cdrs positioned themselves at greater distances from their company's center of mass (Table 28) than did the M1 Baseline Co Cdrs. Similarly, the measures representing unit dispersion (Table 28) indicated that the CVCC equipped units maintained greater dispersion while executing the offensive phases. However, these trends were not statistically significant. In a MANOVA on the three dispersion measures plus the Co Cdrs' positioning measure, neither of the main effects (condition and phase) nor the condition by phase interaction was significant.

Table 28

Operational Control of Unit Measures for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I	Phase II	Phase I	Phase II
% rounds fired by Co Cdr & Plt Ldr crews	16.1 (16.1) n=20	14.9 (14.4) n=20	15.0 (21.2) n=16	16.2 (19.3) n=16
Co Cdr distance from company center of mass	684.6 (388) n=5	719.5 (444) n=5	479.1 (244) n=4	407.5 (234) n=4
% time company dispersion >600 m	89.4 (10.1) n=5	96.2 (8.4) n=5	66.5 (36.7) n=4	71.9 (24.8) n=4
% time 2d plt dispersion >200 m	69.7 (13.7) n=5	57.7 (31.5) n=5	27.0 (31.8) n=4	23.2 (19.2) n=4
% time 2d plt dispersion <100 m	4.8 (7.41) n=5	15.0 (25.5) n=5	27.4 (18.4) n=4	24.9 (23.6) n=4

Defensive Scenario

The dispersion measures were not applied to the defensive scenario, because of the relatively small proportion of mission execution time spent in tactical movement.

Means for the percent of rounds fired by the Co Cdr and Plt Ldr crews in the defensive scenario appear in Table 29. As in

the offensive scenario, the means were slightly above the "even share" level for both conditions in Phases I and II. The effect of condition was not significant. The importance of these findings in documenting CVCC leaders' participation in fighting the battle, discussed earlier, applies equally here.

Table 29

Operational Control of Unit Measures for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I	Phase II	Phase I	Phase II
% rounds fired by Co Cdr & Plt Ldr crews	14.8 (5.0) n=20	15.6 (7.8) n=20	17.1 (13.1) n=16	16.4 (15.2) n=16

Summary of Findings

The hypothesis that C^2 responsibilities of the Co Cdr and Plt Ldrs would reduce their involvement in direct engagements was not supported. The vehicles associated with leadership positions accounted fully for their "even share" of the manned vehicle firings. This finding is especially important because it demonstrates that leaders' vehicles equipped with the CVCC were able to participate fully in fighting the battle.

The expectation that the CVCC Co Cdrs would have greater flexibility in positioning their tanks was not confirmed statistically. During movement-intensive offensive phases, CVCC Co Cdrs were able to exercise control of their units while maintaining greater distance from their company's center of mass. However, the differences between the CVCC and M1 Baseline conditions were not statistically significant. The observed trend is indicative of performance to be expected in future research.

Obtained only for the offensive scenario, the dispersion data provided moderate support of, but did not confirm statistically, the hypothesis that CVCC equipped units would have greater flexibility of unit movement. The enhanced control capabilities of the automated C^3 equipment enabled the CVCC units to move tactically using more dispersed formations, as indicated by both company and platoon dispersion. The trends were consistent across measures. These findings suggest the CVCC afforded the Co Cdr and his Plt Ldrs greater flexibility in moving without compromising unit control. Confirmation of this awaits future research.

Positioning and Navigating

Issue: What is the effect of the CVCC on platoon and company movement?

Guiding the analysis of data bearing on tactical movement of the platoon and company were four functional hypotheses:

1. The CVCC's integrated capabilities, including the driver's steer-to display and the vehicle commander's tactical map with POSNAV icons and overlays, should produce savings in distance travelled and fuel consumed.

2. The CVCC Plt Ldr's ability to monitor his tanks' locations and movement is expected to enable, on average, greater speed of tactical movement.

3. The POSNAV capabilities should reduce the time which CVCC vehicles spend stopped to check the location of one's own tank or other unit vehicles.

4. The CCD's digital routes, overlays, and mutual POSNAV icons can be expected to result in fewer friendly vehicles straying out of sector.

The measures related to unit positioning and navigation include: distance travelled; fuel used; mean velocity (while moving); percent of time when moving velocity exceeded 40 km/hr; percent of time spent at halt (offense only); and number of times each vehicle travelled out of sector.

Offensive Scenario

In executing both Phases I and II of the offensive scenario, the M1 Baseline units travelled a greater distance and used more fuel (Table 30). Data for distance travelled and fuel used were analyzed in a MANOVA. The effect of condition was significant (Pillai's Trace = .309, $p < .001$), as was the effect of phase (Pillai's Trace = .954, $p < .001$), the latter result being directly related to the longer movement requirement scripted in Phase I. These findings indicate the automated equipment resulted in less wasted movement and substantial fuel savings.

For neither (a) mean velocity while moving nor (b) percent of the time spent travelling faster than 40 km/hr was the mean difference favoring CVCC units significant. It appeared that movement velocity, on the average, was governed largely by terrain characteristics and doctrinal movement procedures.

CVCC equipped units spent a significantly smaller proportion of the mission execution time at halt than did the M1 Baseline units ($F(1, 53) = 18.80$, $p = .0001$). This finding reflected the relatively high frequency with which M1 Baseline vehicles stopped to confirm their location, verify the route ahead, etc. Thus, the CVCC units were able to sustain their tactical movement on a

more continuous basis, with fewer interruptions and less wasted time. This finding corresponds closely to patterns found in Du Bois and Smith's (1989; 1990) earlier work with the POSNAV and IVIS systems. Multiple CVCC capabilities--CCD tactical map, POSNAV, and CITV--likely contributed to this trend.

The measure quantifying instances of vehicles travelling outside the boundaries of the company sector (Table 30) reflected misorientation, mistaken location, incorrect headings, etc. While the CVCC vehicles tended to stray out of sector less often than their M1 Baseline counterparts, the effect of condition was not significant.

Table 30

Unit Positioning and Navigation Measures for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I	Phase II	Phase I	Phase II
Distance travelled (km)	20.1 (2.4) n=27	10.7 (1.7) n=27	24.2 (3.8) n=28	12.1 (1.4) n=28
Fuel used (gal)	26.6 (6.7) n=27	14.7 (5.6) n=27	37.2 (9.2) n=28	18.7 (5.4) n=28
Mean velocity (while moving) (km/hr)	32.2 (6.1) n=34	36.1 (7.6) n=34	29.0 (3.6) n=28	34.3 (7.4) n=28
% time moving velocity >40 km/hr	31.1 (15.1) n=34	43.8 (20.9) n=34	24.1 (12.1) n=28	42.0 (13.7) n=28
% time at halt	35.2 (8.3) n=34	48.9 (10.6) n=34	43.7 (9.3) n=28	58.4 (12.8) n=28
# times vehicle out of sector	2.28 (5.2) n=35	.11 (.32) n=35	4.86 (11.8) n=28	.04 (.19) n=28

Defensive Scenario

Table 31 contains the data from the defensive scenario for the unit positioning and navigation measures. Lacking POSNAV capabilities, the M1 Baseline units travelled further and used

more fuel in accomplishing both phases. A MANOVA on both measures revealed a significant effect of condition (Pillai's Trace = .157, p = .011) and phase (Pillai's Trace = .345, p < .001). The phase effect reflected the longer tactical movement distance scripted in Phase I. These findings mirrored those found for the offensive scenario, indicating significant savings even when mission execution involved less tactical movement.

Mean velocity while moving was nearly identical for the two conditions; faster velocities during Phase I (compared to Phase II) probably resulted from the displacement nature of the movement, with the enemy in pursuit. The percent of the time spent travelling faster than 40 km/hr was similar for the two conditions in Phase I, but modestly favored CVCC units in Phase II. For neither velocity measure was the effect of condition significant.

The M1 Baseline vehicles wandered out of sector more often than the CVCC vehicles, but the effect of condition was not significant.

Table 31

Unit Positioning and Navigation Measures for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC		M1 Baseline	
	Phase I	Phase II	Phase I	Phase II
Distance travelled (km)	7.0 (1.8) n=28	3.4 (2.2) n=28	7.7 (4.5) n=28	4.9 (2.6) n=28
Fuel used (gal)	12.6 (2.7) n=28	7.8 (3.3) n=28	16.3 (9.0) n=28	11.8 (6.7) n=28
Mean velocity (while moving) (km/hr)	41.5 (10.3) n=35	33.5 (13.4) n=35	41.3 (9.9) n=28	32.8 (10.4) n=28
% time moving velocity >40 km/hr	55.6 (18.6) n=35	46.8 (23.8) n=35	58.9 (18.5) n=28	38.5 (21.3) n=28
# times vehicle out of sector	1.00 (3.0) n=35	.94 (2.7) n=35	2.71 (6.1) n=28	1.21 (3.2) n=28

Summary of Findings

As expected, significant savings in distance travelled and fuel consumed occurred for CVCC equipped vehicles. These trends were found in both the offensive and defensive scenarios. These findings indicate the CVCC's enhanced capabilities resulted in less wasted movement and substantial fuel savings, regardless of scenario type. Previous CCTB research with POSNAV (Du Bois & Smith, 1989) and IVIS (Du Bois & Smith, 1990) produced essentially the same results at the platoon level.

The hypothesized increase in speed of tactical movement for CVCC equipped vehicles did not materialize. When the units were on the move, speed of movement did not differ between the CVCC and M1 Baseline conditions. Movement speed appeared to be governed primarily by characteristics of the terrain and the scenarios.

The hypothesis that CVCC capabilities would reduce the need to stop to check location received support in the offensive scenario, when the CVCC equipped companies spent a significantly smaller proportion of their time at a halt. The CVCC units were able to accomplish tactical movement with fewer interruptions and less wasted time.

The hypothesis that digital routes and overlays would reduce the number of vehicles straying outside sector boundaries was not confirmed.

In their comments about the benefits of the CCD, the participants were enthusiastic about the equipment's capabilities to assist in tactical movement. Approximately two-thirds of the comments on this subject highlighted the map and POSNAV functions of the CCD. At the same time, about one-quarter of the participants stated they used the CITV for orientation, navigation, and maintaining their position within the unit formation.

Engaging the Enemy

Issue: How does the CVCC affect engagement of enemy forces?

The functional hypotheses guiding the analysis of data related to engaging the enemy were as follows:

1. The automated capabilities of the CVCC, particularly the CITV's hunter-killer advantage, are expected to lead to increased target acquisition and engagement ranges.

2. The same factors should enhance CVCC units' effectiveness in destroying enemy vehicles.

3. The CVCC's integrated capabilities, especially independent surveillance with the CITV plus the tactical map's icons showing reported enemy locations, should reduce damages from enemy direct fire.

The measures quantifying target acquisition and engagement performance include: maximum lasing range; median target hit and kill ranges; percent of targets hit and killed at ranges greater than 2200 m; number of hits taken by manned vehicles; number of targets hit using Designate and Target Stack; percent of enemy vehicles killed; percent of enemy kills scored by manned vehicles; and number of manned vehicle losses. The latter three were shared with the mission performance category.

Offensive Scenario

Maximum lasing range (Table 32) averaged more than 400 m greater for CVCC units than for M1 Baseline companies. This indicated target acquisition began substantially further out for the CVCC equipped crews, arguably due to the searching and lasing capabilities of the CITV. The median ranges for target hits and target kills (Table 32) tended to favor the CVCC units. A MANOVA was performed on maximum lasing range, median target hit range, and median target kill range. The condition effect, phase effect, and condition by phase interaction all fell short of significance. The proportions of hits and kills occurring beyond 2200 m were comparable for the CVCC and M1 Baseline conditions. These two measures were not analyzed statistically, since the distributions contained numerous zero values.

As discussed in the earlier subsection addressing mission performance (Table 22), the CVCC companies killed a higher proportion of enemy vehicles during Phase I, but the condition effect for the overall scenario was not significant. The proportion of enemy kills scored by manned tanks (Table 22) did not differ significantly between the two conditions.

During the offensive scenario, the CVCC crews hit targets using Designate infrequently (the average per phase being less than .20 per crew). Target hits resulting from the use of Target Stack were rare. See Ainslie et al. (1991) for usage figures for these special target management functions, including documentation of decreasing usage as echelon increased.

Relatively few hits were taken by manned vehicles during the offensive scenario (Table 32). The effect of condition for this measure was not significant. Likewise, the number of manned vehicle losses (Table 22) did not differ significantly between the CVCC and M1 Baseline conditions, as documented in the earlier subsection on mission performance.

Table 32

Target Acquisition and Engagement Measures for Offensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC Phase I	CVCC Phase II	M1 Baseline Phase I	M1 Baseline Phase II
Maximum lasing range (m)	2909 (738) n=34	2820 (943) n=27	2568 (1197) n=26	2326 (1095) n=26
Median target hit range (m)	1240 (596) n=21	1002 (494) n=20	1022 (574) n=14	781 (553) n=18
% targets hit >2200 m	10.0 (24.2) n=21	8.8 (23.6) n=20	8.6 (15.5) n=14	1.4 (5.9) n=18
Median target kill range (m)	1156 (558) n=18	1210 (696) n=17	854 (681) n=11	851 (540) n=14
% targets killed >2200 m	1.8 (7.9) n=18	19.3 (39.1) n=17	9.1 (30.2) n=11	0 (0) n=14
# hits taken by manned vehicles	2.26 (4.3) n=35	.51 (2.2) n=35	1.25 (2.4) n=28	.96 (3.1) n=28

Defensive Scenario

As in the offensive scenario, maximum lasing range (Table 33) for CVCC units out-distanced that for M1 Baseline companies by more than 400 m, on average. This trend suggested the CVCC equipment substantially extended the target acquisition range. The median ranges for target hits and target kills favored the CVCC units. Maximum lasing range, median target hit range, and median target kill range were analyzed in a MANOVA. The effect of condition was significant (Pillai's Trace = .370, p = .008), as was the effect of phase (Pillai's Trace = .344, p = .013). The condition by phase interaction was not signficant. The percentages of hits and kills occurring beyond 2200 m were not analyzed statistically, since the distributions contained numerous zero values. However, the mean differences for these two measures substantially favored the CVCC equipped companies.

Table 33

Target Acquisition and Engagement Measures for Defensive Scenario, by Condition and Phase: Means and Standard Deviations (in parentheses)

Measure	CVCC Phase I	CVCC Phase II	M1 Baseline Phase I	M1 Baseline Phase II
Maximum lasing range (m)	3373 (494) n=35	3091 (586) n=28	2917 (932) n=28	2547 (1012) n=28
Median target hit range (m)	1734 (461) n=32	1653 (500) n=31	1381 (390) n=23	1506 (537) n=22
% targets hit >2200 m	26.9 (30.9) n=32	20.4 (28.8) n=31	5.8 (11.8) n=23	9.0 (24.5) n=22
Median target kill range (m)	1817 (437) n=30	1599 (613) n=28	1335 (466) n=20	1318 (427) n=16
% targets killed >2200 m	27.1 (34.4) n=30	25.7 (36.6) n=28	12.0 (24.1) n=20	4.1 (11.4) n=16
# hits taken by manned vehicles	26.1 (35.9) n=35	7.2 (19.6) n=35	55.4 (76.8) n=28	3.8 (5.9) n=28

Two relevant measures were discussed in the earlier subsection addressing mission performance. The proportion of enemy vehicles killed and the proportion of enemy kills scored by manned tanks (Table 23) did not differ significantly between the two conditions.

As in the offensive scenario, the use of Designate accounted for only infrequent target hits (the average per phase being less than .30 per crew). Target hits rarely resulted from the use of Target Stack. Usage data for these special target management functions were presented by Ainslie et al. (1991), who documented decreasing usage with increasing echelon.

Manned vehicles took frequent hits during the defensive scenario (Table 33). M1 Baseline vehicles tended to sustain more hits than CVCC vehicles, but the effect of condition was not significant for this measure. Similarly, the number of losses taken by manned tanks (Table 23) did not differ significantly

between the two conditions, as documented in the earlier subsection on mission performance.

Summary of Findings

The hypothesis that the CVCC's enhanced capabilities, especially those of the CITV, would increase target acquisition and engagement ranges was supported by data from the defensive scenario. Maximum lasing range, median target hit range, and median target kill range were significantly greater among CVCC units. Though these trends also occurred during offense, they were significant only in the defense. In line with these findings, Quinkert (1990) reported a stronger advantage of the CITV during defensive missions, where it was especially effective against long range moving targets.

The expected improvement in CVCC vehicles' ability to destroy enemy targets did not occur. The proportion of enemy vehicles killed and the proportion of enemy kills scored by manned vehicles did not differ significantly between the CVCC and M1 Baseline conditions in either scenario. This may have been largely due to the structure of the test scenarios, as discussed in the earlier subsection on mission performance.

The data failed to confirm the expectation of reduced damages for the CVCC equipped vehicles. The number of hits and kills sustained by manned tanks did not differ significantly between the CVCC and M1 Baseline units. The kill-suppress feature protecting manned vehicles may have blunted the incentive to avoid hits from enemy fire. Indeed, on occasion it appeared to encourage risk-taking behavior. Future research should address this issue as realistically as possible.

CVCC-Unique Measures

Several measures were unique to the CVCC condition, because of the CCD and CITV capabilities: percent of the time the vehicle commander used the various visual devices available; percent of named reports transmitted by voice radio; percent of reports retrieved; percent of reports relayed; median time to retrieve reports; and median time to relay reports.

Use of Visual Devices

In gathering visual information about the battlefield situation, the vehicle commanders in the CVCC condition could use their vision blocks, GPSE, CITV, or CCD tactical map. To determine the relative usage of these devices, at the end of each scenario the RAs estimated the percentage of time each vehicle commander used the different devices. (Data for M1 Baseline vehicle commanders' use of vision blocks and GPSE were not analyzed because they would not be comparable to the CVCC measures.) The data were broken out by type of duty position, or echelon, with the three Plt Ldr positions grouped together and the Plt Sgt plus the two wingmen together in a separate group

labelled "TC." Data were averaged across phases to produce a mean value for each visual device in each scenario.

Data from the offensive scenario appear in Table 34. The patterns across visual devices varied substantially for the three types of duty positions. At the lowest echelon (TC), the CITV was used slightly more than a third of the time, followed closely by the CCD tactical map; vision blocks were used 20% of the time. This pattern is consistent with a search-and-kill focus expected at the lower levels. Among the Plt Ldrs, the CITV and CCD tactical map were used almost equally, accounting for nearly 85% of the visual surveillance activity. This pattern may have reflected more balance between target acquisition and unit leadership activities. At the Co Cdr's level, use of the CCD tactical map dominated strongly, consistent with the attendant command and control responsibilities. The effect of duty position was significant for vision blocks ($F(2, 25) = 4.72$, $p = .018$) and CCD tactical map ($F(2, 25) = 6.31$, $p = .006$).

The relatively small proportion of time spent using vision blocks and GPSE is not surprising, considering the large amount of visually-oriented information available to the vehicle commander through the CITV and the CCD tactical map. The combined performance data (especially for mission performance and target engagement) clearly indicate CVCC vehicle commanders had ample battlefield information available to them. Of particular interest is the finding that CVCC Co Cdr and Plt Ldr crews

Table 34

Percent of Time the Vehicle Commander Used Each Available Visual Device during the Offensive Scenario, by Type of Duty Position: Means and Standard Deviations (in parentheses)

Visual Device	Duty Position		
	Co Cdr n=4	Plt Ldr n=12	TC n=12
Vision Blocks	8.25 (6.99)	7.75 (3.74)	20.2 (14.9)
GPSE	1.50 (2.38)	8.08 (6.36)	7.25 (5.10)
CITV	21.5 (26.9)	42.5 (8.62)	37.7 (20.4)
CCD Tactical Map	68.8 (30.9)	41.7 (9.37)	34.1 (17.4)

participated fully in firing on enemy targets, as did their M1 Baseline counterparts (see earlier subsection on directing and leading the unit). This is an important point, demonstrating that the CCD did not detract from the vehicle commander's ability to fight his tank.

Table 35 summarizes the observations regarding the use of visual devices for the defensive scenario. Here the patterns were quite similar to those seen in the offensive scenario, varying greatly between the three types of duty positions. The search-and-kill focus at the TC level was apparent again. Among the Plt Ldrs, CITV use exceeded CCD tactical map use substantially, in contrast to the offensive scenario, suggesting greater reliance on the CITV for controlling platoon combat activities in the defense. At the Co Cdr's level, use of the CCD tactical map again dominated strongly, consistent with increased command and control responsibilities. ANOVAs revealed that the effect of duty position was significant for vision blocks ($F(2, 25) = 3.91$, $p = .033$), GPSE ($F(2, 25) = 3.69$, $p = .039$), CITV ($F(2, 25) = 8.70$, $p = .001$) and CCD tactical map ($F(2, 25) = 6.31$, $p < .001$).

Table 35

Percent of Time the Vehicle Commander Used Each Available Visual Device during the Defensive Scenario, by Type of Duty Position: Means and Standard Deviations (in parentheses)

Visual Device	Duty Position		
	Co Cdr n=4	Plt Ldr n=12	TC n=12
Vision Blocks	8.50 (7.94)	8.25 (5.24)	22.5 (18.9)
GPSE	2.75 (2.06)	7.00 (4.79)	10.2 (5.51)
CITV	15.0 (9.13)	50.4 (11.0)	38.4 (18.9)
CCD Tactical Map	73.8 (13.8)	35.1 (13.7)	29.0 (11.8)

In summary, the patterns with which vehicle commanders used the available visual devices varied, depending on echelon within the unit. Co Cdrs relied predominantly on the CCD tactical map--much more heavily than TCs, with Plt Ldrs falling in between these two groups. Plt Ldrs and TCs were more balanced in their use of the CCD tactical map and the CITV. Among the three

echelons, Plt Ldrs relied most heavily on the CITV to monitor the battlefield.

Report Handling

Ten different types of reports, including navigation routes, could be prepared using the CCD. To represent the relative frequency of CCD reports generated during the offensive scenario, the average number of each report type was computed as a percentage of the total reports generated. The results of this analysis appear in Table 36, with all three phases represented. Considering the entire scenario, the most commonly prepared report was the SITUATION report, followed by CONTACT, ADJUST FIRE, SPOT, SHELL, and CALL FOR FIRE reports, in that order. NBC and AMMUNITION reports, along with navigation routes, were prepared relatively infrequently.

Table 36

Relative Distribution of CCD Reports Originated by Co Cdr and Plt Ldrs during Offensive Scenario, by Type and Phase: Percent of Total Reports Originated

Report Type	Phase I n=20	Phase II n=19	Phase III n=18
CONTACT	14.7	12.8	12.3
SHELL	9.5	14.5	12.3
CALL FOR FIRE	12.6	11.1	8.1
ADJUST FIRE	14.7	7.3	19.3
SPOT	9.5	16.3	12.3
SITUATION	25.3	29.1	22.0
AMMUNITION	4.2	0	5.4
NBC	6.3	---	---
Navigation Route	3.2	9.0	8.1

Table 37 presents the relative frequencies of CCD reports generated during the defensive scenario. Integrating across the three phases, the most commonly prepared reports were the CALL FOR FIRE and ADJUST FIRE reports. These were followed by the CONTACT, SHELL, SITUATION, and SPOT reports, in that order. NBC

and AMMUNITION reports, as well as navigation routes, were prepared infrequently.

Table 37

Relative Distribution of CCD Reports Originated by Co Cdr and Plt Ldrs during Defensive Scenario, by Phase: Percent of Total Reports Originated

Report Type	Phase I n=15	Phase II n=19	Phase III n=18
CONTACT	14.7	14.3	10.9
SHELL	12.0	8.2	17.2
CALL FOR FIRE	20.0	24.5	28.1
ADJUST FIRE	22.7	26.5	25.0
SPOT	6.7	8.2	4.7
SITUATION	14.7	12.2	6.2
AMMUNITION	1.3	2.0	4.7
NBC	4.0	---	---
Navigation Route	4.0	4.1	3.1

In order to view a report received on the CCD, the vehicle commander had to retrieve it from the receive queue or an old file. For every report type, retrieval was optional. As an index of the relative frequency of retrieval activity, the percent of received reports which each vehicle commander retrieved was computed for each phase. All reports received (unique and non-unique) were tallied, while only the first retrieval for a given report was counted. This procedure is problematic because it does not adjust for the large proportion of duplicate and very similar reports received by each vehicle commander. Duplicate reports resulted from the SINCGARS net structure in combination with the frequent redundant relays (re-relays of the same report) reported by Ainslie et al. (1991). Similar reports resulted from members of the same platoon reporting separately on the same event. Thus only some of the reports available for retrieval contained unique, or new, information. Because of the limited types of reports (CONTACT, SHELL, and SPOT) generated by the tethered vehicles in the first and third platoons, the data for the 1st and 3rd Plt Ldrs were excluded from this analysis.

The retrieval means for each report type are presented in Table 38 for each offensive phase. Over the entire scenario, an average of 36.8 percent of reports were retrieved by each vehicle

Table 38

Percent of Received CCD Reports Retrieved by Vehicle Commanders (except 1st and 3rd Plt Ldrs) during Offensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	33.8 (26.4) n=19	31.9 (39.4) n=17	39.7 (32.5) n=19
SHELL	32.3 (25.8) n=22	20.1 (33.2) n=18	21.0 (27.3) n=21
CALL FOR FIRE	37.2 (42.2) n=9	32.3 (39.4) n=8	60.0 (51.6) n=10
ADJUST FIRE	59.7 (42.3) n=12	23.8 (35.4) n=4	50.0 (54.8) n=6
SPOT	51.9 (34.8) n=21	26.6 (39.1) n=18	39.3 (43.0) n=14
AMMUNITION	33.3 (47.1) n=8	28.6 (48.8) n=7	52.0 (50.2) n=5
SITUATION	46.9 (48.7) n=18	30.1 (42.6) n=14	34.1 (43.8) n=16
FRAGO	---	84.1 (28.4) n=22	77.3 (33.6) n=22
INTELLIGENCE	59.7 (42.0) n=24	45.6 (36.7) n=23	60.7 (48.0) n=19
NBC	51.5 (38.2) n=19	---	---

commander (excluding the 1st and 3rd Plt Ldrs). This apparently low figure undoubtedly reflects the large number of duplicate and similar reports containing non-unique information. Recognition (correct or incorrect) of redundant reports may have accounted for many of the cases where received reports were not retrieved. In addition, retrieval of unique reports may not always have been necessary. The tactical map icon representing the report, along with the type of report and originator displayed in the receive queue, may have provided sufficient information.

Although there was some differentiation among the various types of reports, only two report types stood out: INTELLIGENCE reports and FRAGOs were retrieved at a higher rate than others. Both of these were normally downward travelling reports and may have experienced less duplication. Additional information on report retrieval can be found in Ainslie et al. (1991), in the context of SMI analyses. In particular, strong effects of duty position are documented, along with lower rates of retrieval for the tethered Plt Ldrs than for the manned Plt Ldr. As echelon increased, retrieval rate increased. For example, in the offensive scenario the Co Cdrs retrieved 57% of their reports, compared to 31% retrieved by the TCs.

The means for retrieval of FRAGOs suggest that some vehicle commanders may have operated without the FRAGO text and overlay. However, Ainslie et al. (1991) verified that there were no cases where that occurred.

Over the entire defensive scenario, the relative rate of retrieving reports averaged 32.3% for each vehicle commander (excluding 1st and 3rd Plt Ldrs). As in the offensive scenario, this apparently low figure undoubtedly reflected the large number of duplicate reports as well as the likely sufficiency of information available without retrieval.

Table 39 displays the retrieval means for each report type for each defensive phase. The differentiation among the majority of the different types of reports was quite modest. However, as in the offensive scenario, FRAGOs and INTELLIGENCE reports stood out by virtue of higher retrieval rates than the others. As noted earlier, these were normally downward travelling reports and may have undergone less proliferation. Two additional report types--AMMUNITION and NBC--were retrieved at rates somewhat higher than the others, perhaps reflecting relatively greater importance of these reports in the context of the defensive mission. SMI-based information on report retrieval in the defensive scenario can be found in Ainslie et al. (1991), including strong effects of echelon.

Table 39

Percent of Received CCD Reports Retrieved by Vehicle Commanders (except 1st and 3rd Plt Ldrs) during Defensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	30.3 (31.7) n=19	37.0 (28.6) n=22	25.5 (30.6) n=23
SHELL	31.5 (28.7) n=20	27.0 (32.9) n=25	25.1 (34.5) n=22
CALL FOR FIRE	42.2 (35.3) n=9	26.0 (35.7) n=16	24.2 (37.1) n=13
ADJUST FIRE	15.9 (17.7) n=10	20.0 (31.8) n=15	34.6 (38.3) n=12
SPOT	26.4 (30.8) n=19	19.5 (24.9) n=23	17.2 (30.9) n=15
AMMUNITION	43.6 (47.8) n=7	38.9 (39.8) n=9	57.1 (53.4) n=7
SITUATION	18.9 (32.3) n=14	52.4 (42.3) n=14	24.2 (43.3) n=15
FRAGO	---	73.3 (31.5) n=25	52.9 (30.4) n=24
INTELLIGENCE	37.9 (22.5) n=20	50.8 (38.6) n=22	54.8 (44.4) n=21
NBC	48.5 (45.8) n=13	---	---

When a vehicle commander had reviewed a report received from another vehicle commander (or the battalion staff), he had the option to relay it upward or downward. It should be noted that vehicle commanders at the "bottom" of the radio net (especially the two wingmen) realistically had no call to relay reports, since they were normally either originators or end recipients of reports. To quantify the relative frequency of relaying reports, the percent of received reports which each Co Cdr and Plt Ldr relayed was computed for each phase. All reports received (unique and non-unique) were tallied, while only the first relay for a given report was counted. In other words, the data were not adjusted to remove duplicate and similar reports from the analysis. As in the analysis of report retrieval data, this has a serious impact on interpretation of the findings. Due to the limited incentive for 1st and 3rd Plt Ldrs to relay reports to tethered vehicles and the limited types of reports generated by tethered vehicles, data for these two Plt Ldrs were excluded from this analysis.

The relay means for each report type from the offensive scenario are presented in Table 40, with data organized by phase. There was considerable variability among the means, especially across phases. However, two report types--INTELLIGENCE reports and FRAGOs--were relayed at a substantially higher rate than the others. This is consistent with the pattern observed with report retrievals and may well be related to the lower levels of report duplication presumed to characterize downward travelling reports. On the other hand, SITUATION reports were infrequently relayed, most likely reflecting a practical need to generate new SITUATION reports as information was integrated at each higher echelon. Additional information on report relaying can be found in Ainslie et al. (1991), in the context of SMI analyses. In particular, strong effects of duty position are documented, along with lower rates of relaying for the tethered Plt Ldrs than for the manned Plt Ldr.

The means for percent of received reports relayed by the Co Cdr and 2d Plt Ldr in the defensive scenario appear in Table 41. Again, the means were quite variable. As in the offensive scenario, INTELLIGENCE reports and FRAGOs were relayed at a substantially higher rate than the others. At the same time, SITUATION reports were never relayed, reinforcing the earlier argument that the process of integrating information for SITUATION reports required the creation of new reports. Ainslie et al. (1991) present additional information on report relaying, in the context of SMI analyses.

Table 40

Percent of Received CCD Reports Relayed by Co Cdr and 2d Plt Ldr during Offensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	35.8 (25.7) n=10	36.7 (41.6) n=10	41.7 (28.9) n=10
SHELL	34.6 (29.1) n=10	23.5 (20.9) n=9	18.2 (21.4) n=10
CALL FOR FIRE	33.8 (39.4) n=4	64.6 (29.2) n=4	91.7 (20.4) n=6
ADJUST FIRE	69.1 (41.3) n=7	2.0 (4.5) n=5	68.8 (47.3) n=4
SPOT	40.0 (32.4) n=10	29.0 (28.9) n=10	25.6 (33.5) n=10
SITUATION	11.7 (31.5) n=10	10.5 (17.8) n=8	1.6 (4.4) n=8
FRAGO	---	88.9 (22.0) n=9	85.0 (24.2) n=10
INTELLIGENCE	88.3 (24.9) n=10	85.0 (24.2) n=10	96.3 (11.1) n=9
NBC	49.5 (30.8) n=10	---	---

Table 41

Percent of Received CCD Reports Relayed by Co Cdr and 2d Plt Ldr during Defensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	47.6 (22.4) n=8	34.5 (26.6) n=10	34.7 (24.6) n=9
SHELL	31.4 (19.1) n=8	26.5 (24.8) n=10	33.4 (36.4) n=9
CALL FOR FIRE	44.6 (17.9) n=4	38.2 (39.7) n=10	37.0 (42.7) n=6
ADJUST FIRE	7.9 (10.9) n=5	28.0 (38.7) n=7	27.5 (38.4) n=7
SPOT	38.1 (39.6) n=8	23.7 (31.7) n=10	26.0 (34.9) n=8
SITUATION	0 (0) n=6	0 (0) n=6	0 (0) n=6
FRAGO	---	81.7 (29.9) n=10	75.9 (29.0) n=9
INTELLIGENCE	86.2 (25.6) n=8	61.7 (36.0) n=10	77.8 (36.3) n=9
NBC	51.2 (43.9) n=8	---	---

As an indicator of speed in accessing new information, time to retrieve reports received on the CCD was computed for the Co Cdr, each Plt Ldr, and each TC (Table 42). This measure was defined as elapsed time from arrival of the incoming report in the "receive" queue to the first retrieval of the same report, accomplished by the vehicle commander pressing the "show" key.

The measure was computed for only those reports which were, in fact, received and subsequently retrieved during the phase. No attempt was made to assign values to reports not retrieved. When

Table 42

Median Time (in minutes) for Individual Vehicle Commanders to Retrieve CCD Reports during Offensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	.67 (.63) n=25	.88 (1.39) n=18	1.02 (1.85) n=23
SHELL	1.04 (1.41) n=26	.90 (.98) n=10	1.48 (1.24) n=16
CALL FOR FIRE	1.46 (1.84) n=8	.52 (.67) n=5	1.40 (1.83) n=6
ADJUST FIRE	.91 (.99) n=11	.25 (.09) n=3	.39 (.30) n=3
SPOT	1.22 (1.22) n=28	.95 (1.60) n=17	.93 (.93) n=18
AMMUNITION	1.54 (2.65) n=4	1.56 (.01) n=2	.97 (.88) n=3
SITUATION	4.36 (10.8) n=10	1.30 (.92) n=8	.54 (.49) n=8
FRAGO	---	.64 (.79) n=31	.73 (1.21) n=30
INTELLIGENCE	.60 (1.21) n=27	1.33 (2.19) n=25	.92 (1.58) n=20
NBC	.50 (.52) n=22	---	---

multiple values for a given report type resulted within a single phase, the median value was chosen to represent that vehicle commander because of the latency-type nature of the underlying measurement process.

Of primary interest was the overall relative speed of retrieval among the various types of reports when means were integrated across phases. Most rapidly retrieved were ADJUST FIRE and NBC reports, followed by FRAGOs, CONTACT, and INTELLIGENCE reports. Taking over a minute, on the average, for retrieval were SPOT, SHELL, CALL FOR FIRE, and AMMUNITION reports. SITUATION reports averaged slightly over two minutes for retrieval.

Appearing in Table 43 are the mean retrieval times for the defensive scenario. Means were integrated acorss phases to produce an overall relative speed of retrieval among the various types of reports. Most rapidly retrieved were CALL FOR FIRE reports, followed by FRAGOs, INTELLIGENCE, SHELL, CONTACT, ADJUST FIRE, and SPOT reports. Only three reports took over a minute, on the average, for retrieval--AMMUNITION, NBC, and SITUATION reports. The generally shorter retrieval times in the defense, compared to the offense, may reflect fewer demands on the vehicle commander's attention during the predominantly static defensive phases.

To provide an index of speed in forwarding reports received from other vehicle commanders, time to relay reports on the CCD was determined for the Co Cdr and each Plt Ldr. This measure was computed by subtracting the time of the incoming report's arrival in the "receive" queue from the time of the first relay of the same report. This operational definition assumed a logical chain of behavior on the part of the vehicle commander: retrieval of a report, review of its contents, a decision to forward the report upward or downward (or both), and finally implementation of the decision. Relay times were computed for only those reports which were, in fact, retrieved and subsequently relayed during the phase. No attempt was made to assign values to reports not relayed. When multiple values for a given report type resulted within a single phase, the median value was chosen to represent that vehicle commander because of the latency-type nature of the underlying measurement process.

Table 44 presents the mean relay times for each report type for each phase of the offensive scenario. It is important to note that these means are useful for discerning relative trends and relationships only. In particular, they cannot be compared to mean retrieval times because of the narrower subset of vehicle commanders (Co Cdr and Plt Ldrs) involved in computing relay times and because relayed reports represent a selective subset of reports retrieved. To establish general trends, the overall relative relay speed for the various types of reports was determined by integrating means across phases. Most rapidly relayed were NBC and CALL FOR FIRE reports, followed by ADJUST FIRE reports. Taking over a minute, on the average, for relay

were SHELL, SITUATION, SPOT, CONTACT, INTELLIGENCE, and FRAGO reports.

Table 43

Median Time (in minutes) for Individual Vehicle Commanders to Retrieve CCD Reports during Defensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	.91 (.99) n=19	.84 (1.18) n=23	.76 (.81) n=21
SHELL	.83 (1.25) n=22	.76 (1.26) n=18	.65 (1.04) n=19
CALL FOR FIRE	.30 (.15) n=9	.59 (.51) n=10	.27 (.14) n=5
ADJUST FIRE	.47 (.43) n=6	1.33 (2.12) n=7	.80 (.80) n=8
SPOT	1.20 (1.40) n=16	.38 (.29) n=18	1.18 (2.24) n=8
AMMUNITION	.99 (.61) n=4	2.00 (2.30) n=7	.29 (.28) n=5
SITUATION	1.51 (2.33) n=5	1.50 (1.45) n=10	.85 (.88) n=8
FRAGO	---	.70 (1.08) n=35	.61 (1.21) n=34
INTELLIGENCE	.73 (.95) n=27	.67 (1.03) n=25	.81 (1.14) n=21
NBC	1.11 (1.14) n=12	---	---

Table 44

Median Time (in minutes) for Co Cdr and Plt Ldrs to Relay CCD Reports during Offensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	1.10 (.90) n=14	1.34 (1.27) n=11	1.30 (2.24) n=10
SHELL	.95 (.65) n=13	.85 (.81) n=8	1.35 (1.02) n=9
CALL FOR FIRE	.56 --- n=1	.39 (.19) n=3	1.05 (1.44) n=4
ADJUST FIRE	.87 (.96) n=3	.19 --- n=1	1.07 (.81) n=2
SPOT	1.58 (1.61) n=14	.62 (.44) n=10	1.02 (.87) n=10
SITUATION	1.39 (1.08) n=2	.74 (.10) n=3	---
FRAGO	---	1.43 (.22) n=5	1.86 (1.40) n=5
INTELLIGENCE	.82 (.49) n=5	1.65 (1.11) n=5	1.50 (2.04) n=6
NBC	.51 (.10) n=5	---	---

To ascertain global trends in retrieval time and relay time data, the two measures from the offensive scenario were analyzed together in a MANOVA with data collapsed across report types. Two indepdendent variables were examined--type of duty position (Co Cdr, Plt Ldrs, TCs) and phase. Neither variable exhibited a significant effect, nor did the position by phase interaction.

The mean relay times for each report type for the defensive scenario appear in Table 45. As mentioned earlier, these means are useful for discerning relative trends and relationships only. Based on overall relative relay speed, the reports most rapidly forwarded were SHELL and CALL FOR FIRE reports, followed by ADJUST FIRE, INTELLIGENCE, SPOT and NBC reports. CONTACT reports took over a minute, on the average, for relay while FRAGOs took over two minutes.

Table 45

Median Time (in minutes) for Co Cdr and Plt Ldrs to Relay CCD Reports during Defensive Scenario, by Type and Phase: Means and Standard Deviations (in parentheses)

Report Type	Phase I	Phase II	Phase III
CONTACT	1.86 (1.71) n=13	.67 (.50) n=8	.86 (.61) n=12
SHELL	.87 (.74) n=11	.47 (.23) n=11	.44 (.21) n=10
CALL FOR FIRE	.52 (.15) n=4	.91 (.83) n=6	.43 (.08) n=3
ADJUST FIRE	.29 (.11) n=2	.98 (.79) n=4	1.07 (1.12) n=4
SPOT	1.31 (1.42) n=9	.53 (.40) n=9	.80 (.49) n=5
SITUATION	---	---	---
FRAGO	---	2.05 (.54) n=5	2.47 (1.41) n=5
INTELLIGENCE	.73 (.33) n=5	.77 (.80) n=5	1.07 (1.27) n=5
NBC	.90 (.46) n=5	---	---

Retrieval time and relay time data (collapsed across report types) from the defensive scenario were analyzed together in a MANOVA. Neither type of duty position (Co Cdr, Plt Ldrs, TCs) nor phase exhibited a significant effect, nor did the position by phase interaction.

Limitations of the Evaluation

As pointed out in the Background and Review of Key Literature section, the CCTB research environment offers advantages as well as disadvantages. A full interpretation of the evaluation's results, especially their generality, depends on an understanding of the simulation constraints which may have impacted the data. A brief discussion of the major limitations of the evaluation follows.

By virtue of their basic design, the tank simulators modeled only daytime, fair-weather, unobscured environmental conditions. While the closed-hatch mode would be characteristic of operating on a contaminated battlefield and the auto-loading configuration is planned for future tanks, neither of these features fully represented realistic battlefield conditions. Further compromising operational realism was the limited visual terrain database servicing mediated views of the "outside" world.

The closed-hatch, visually simulated world of the CCTB prevented the use of a compass for navigating. This required crews in the M1 Baseline condition to exercise navigation procedures unique to the simulators lacking automated navigational aids. As a result, the unit movement findings may overestimate the advantage of the CVCC configuration.

With the "kill-suppress" feature activated, the participants in both conditions quickly learned their tanks were invincible. A nominally fatal hit generated no feedback to the crew nor any operational penalty. These features may have led to greater risk-taking behavior, biasing basic engagement parameters (e.g., enemy kills scored, hits taken).

The company staffing in this evaluation did not include an executive officer or a fire support officer, both of which are normally incumbent in a tank company. This could have influenced workload on the Co Cdr, with accompanying effects on CCD and CITV usage patterns. Further, the company's command and control dynamics may have been affected.

From a motivational perspective, operational realism during test scenarios depended almost totally on role-playing by the participants. Personal or unit pride and friendly competition appeared to be fairly effective motivators. However, as with any combat simulation, generalizing the findings to the "real world" requires caution and common sense.

Fleshing out two of three platoons with semiautomated tanks tethered to the platoon leader's vehicle limited the unit

dynamics within these platoons. The impact of this constraint, including tethered vehicles' generation of only three types of automated reports, was pointed out as part of the presentation of pertinent data. Additional discussion of this point can be found in Ainslie et al. (1991).

Methodological Implications

A review of the methodology used in this evaluation, with a focus on limitations, leads to several suggestions for enhancing the interpretability and generality of data which might be collected using the CCTB in the future.

To help offset the artificiality of the kill-suppress feature, clear feedback should be provided immediately to the entire crew when a hit which would have a killing effect is sustained. An operational penalty, such as a brief "time-out" period, could be adopted. In addition, feedback could be displayed publicly on an exercise scoreboard showing unit (platoon or company) hits and losses taken. If the scoreboard were to display hits and losses inflicted on the enemy, as well, it could serve as a general motivating factor.

Communication capabilities of tethered SAFOR vehicles should be expanded to enhance the realism of the simulation as larger unit operations force greater reliance on tethered elements. The emphasis should undoubtedly be on automated reports, which will require realism in terms of timing, quantity and content. However, voice radio role-playing of subordinate leaders should not be neglected.

To enhance the role of statistical analyses in data interpretation and decision making, adequate sample sizes should be obtained. Ambiguous data points can cloud interpretation of trends and obscure potentially important relationships. Reasonable statistical power will help reduce the number of equivocal data sets.

The task organization of the friendly forces configured for evaluations should be as realistic as possible. Positions critical to command and control activities by virtue of Army doctrine and practice should be incorporated. This is expected to be especially important at the battalion level, where C^3 interactions are more complex.

Conclusions and Recommendations

Conclusions

Based on the performance of tank companies in the simulated combat environment of the CCTB, the findings of the evaluation support the following conclusions:

1. The enhanced capabilities of the CVCC increased the speed of mission execution, enabling CVCC equipped units to complete all phases of each scenario.

2. The CVCC's advantages in processing and disseminating information enabled Co Cdrs to prepare and send FRAGOs which were more complete and which led to more timely start of mission execution.

3. The enhanced information characteristics of the CCD led to fewer questions about FRAGOs and INTELLIGENCE reports by CVCC equipped vehicle commanders.

4. The CVCC's advantages in assessing the tactical situation and acquiring/communicating information enabled vehicle commanders to prepare and send CONTACT reports that were more accurate. The advantages also enabled CVCC units to conduct a more timely displacement during the delay phase.

5. The less accurate recall of battlefield map features by CVCC vehicle commanders indicates a need for further research.

6. CVCC equipped vehicles commanded by unit leaders (Co Cdrs and Plt Ldrs) participated fully in fighting the battle.

7. The CVCC's enhanced capabilities produced savings in distance traveled and fuel consumed.

8. The CVCC enabled companies to sustain tactical movement with fewer interruptions and less wasted time.

9. The CVCC's target acquisition and engagement advantages enhanced maximum lasing range, target hit range, and target kill range during defensive phases.

10. The net-wide routing of digital reports and the absence of feedback confirming reception led to numerous duplicate reports.

Recommendations for CVCC Improvement

Based on the observations and performance results of this evaluation, several recommendations for improving the CVCC configuration are offered. Ainslie et al. (1991) present detailed recommendations based on SMI findings.

1. Methods should be developed to signal reception of a transmitted report. This would provide confirmation to the sender that the intended receiver is in possession of the report.

2. Duplicate reports should be filtered to reduce the volume of redundant information.

3. Continuing development of digital report formats should strive for ease and speed of preparation, as well as enhanced accuracy.

4. Capabilities to prepare and process free text reports should be developed. This recommendation is based on the fact that CVCC vehicle commanders frequently transmitted voice radio messages which did not fit established report formats.

5. Capabilities should be developed to automatically input resource status information (ammunition, fuel, vehicle systems) to SITUATION reports. This was a common recommendation of vehicle commanders.

6. Further research should be conducted to determine if using the CVCC reduces the vehicle commander's map awareness.

7. Regarding Target Stack, system redesign or alternative training approaches should be investigated.

Recommendations Regarding Methodology

A number of lessons learned in the current evaluation pertain to research methodology and procedures, including measurement and data analysis procedures. Recommendations for methodology of future research efforts follow.

1. To reduce performance variability, participants meeting a consistent level of experience (especially involving unit training in the field) should be obtained. Soldiers from combat maneuver units are preferable, and intact units are highly desireable.

2. Basic groups should contain adequate sample sizes, determined on the basis of statistical requirements and likelihood of data losses. In addition, repeated measures designs can enhance statistical power.

3. To reinforce realistic role playing with the kill suppress feature in effect, a hit which would have a killing effect should be signalled clearly to the crew. A conspicuous auditory cue, for example, or a "time out" period, could be employed. In addition, an exercise scoreboard could display hits and losses for each unit soon after completing a scenario.

4. Additional positions critical to armor operations should be incorporated in the task organization of friendly forces, for future experiments, eg., executive officers.

5. Efforts underway to expand automated report capabilities of SAFOR vehicles should be followed through to enhance the realism of the simulation environment.

6. Methods should be explored to assess current awareness of the tactical situation.

7. A variety of performance measures should be improved. Time to loss of mission effectiveness should be modified to focus on the time mission effectiveness is maintained, and the six-vehicle criterion should be confirmed. Criterion measures should be assessed with an eye to converting them where feasible to error scales relying on automated computation.

8. Data reduction procedures should incorporate echelon as an analytical variable wherever appropriate, especially when direct operation of CVCC equipment is involved.

9. Reduction of digital report handling measures should account fully for redundant report actions and adjust data to control for duplicate reports.

10. Alternative experimental approaches or statistical analysis procedures are needed to compensate for small sample sizes. Within-subjects designs (e.g., cross-over) or repeated measures approaches, such as iterative scenarios, may be helpful.

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Appendix A

Tactical Scenario Materials

Appendix A contains the following:

Appendix A-A

Offensive Test Tactical Scenario Materials

The table of contents for Appendix A-A, the Offensive Test Tactical Scenario Materials, is as follows:

CVCC EVALUATION
OFFENSIVE TEST SCENARIO

Battalion OPORD 9-20

Copy ____ of ____ Copies
TF 1-10 ARMOR, 1st BDE,
23 Armor Division (AD)
ET862017
271200 SEP 2000

REFERENCES: Map Series V753, V751 Kentucky - Indiana, Sheets M3753 I, II, III, IV; M3760 II, III, Edition 1-AMS, 1:50,000.

Time Zone Used Throughout the Order: Romeo

Task Organization:

A/1-10 ARMOR (AR)	TEAM B	TEAM C
	D/1-10 AR	
	B/1-10 (-)	C/1-91 IN (-)
	3/C/1-91 INFANTRY (IN)	3/B/1-10 AR
	1/A/23 ENGINEER (EN)	

Task Force (TF) CONTROL	TF TRAINS
SCOUT PLT/1-10 AR	MISSION SUPPORT TEAM (MST)/B/1 FIRE
HEAVY MORTAR PLT/1-10 AR	SUPPORT BATTALION (FSB)
1/A/1-244 AIR DEFENSE ARTILLERY (ADA) (V/S)	

1. SITUATION

A. Enemy.

(1) Overview: The 8th Combined Arms Army (CAA), after a successful attack, has established a hasty defense (Vicinity [VIC] 92 East-West Gridline) in order to establish lines of communications and supply with its rear area. Enemy contact has been lost throughout the Brigade (BDE) sector. The 39 Guards Motorized Rifle Division (GMRD) is believed to be in the 1 BDE sector, with the 146th Motorized Rifle Regiment (MRR) (BMP) in the TF 1-10 sector.

(2) Composition and Disposition: The 39th GMRD consists of the 140th MRR (BTR), the 144th MRR (BTR), the 146th MRR (BMP), and the 79th Tank Regiment (TR). The overall strength of the division is 40-50%. The 140th and 144th MRRs are equipped with BTR-80s and the 146th MRR with BMP-2s. Tank battalions of the MRRs have T-80 tanks. The 79th Tank Regiment is thought to have Future Soviet Tanks (FST-1).

(3) Most Probable Course of Action: The 39th GMRD is economizing forces in a defensive belt in the vicinity of Elizabethtown (ES9971). The 146th MRR (BMP) is currently conducting a withdrawal to consolidate its defensive efforts vicinity Elizabethtown to the southeast. The 146th MRR will have a covering force deployed in the TF 1-10 sector consisting of platoon size and smaller elements. A rear guard consisting of a company (+) size

element will probably be delaying in the vicinity of OBJECTIVE (OBJ) COPPER (ES8472).

B. Friendly.

(1) 1st BDE, 23AD conducts a movement to contact 280500 SEP 2000 to seize OBJs COPPER and BRASS (ES9473) and to regain contact with the enemy.

(2) TF 1-91 conducts movement to contact on the eastern flank to seize OBJ BRASS.

(3) 2nd BDE conducts movement to contact on the western flank to envelop the enemy as part of the division pursuit.

(4) TF 3-4 AR, 3rd BDE, 52 Infantry Division (ID) defends from battle positions along Line of Departure (LD)/Phase Line (PL) NASH.

(5) 1-12 ARMOR follows TF 1-10.

(6) 1-50 Field Artillery (FA) (155MM SP) reinforces 1-50 (155MM SP) is in Direct Support to 1st BDE, 1-51 FA.

(7) No air support is available.

C. Attachments and Detachments. See Task Organization.

2. MISSION. 1-10 ARMOR conducts movement to contact at 280500 SEP 2000, to gain contact with enemy forces and seize OBJs BRONZE, TIN, and ZINC (vic ES800805), On Order (O/O) seize OBJ COPPER (ES850720) as BDE main effort.

3. EXECUTION. Annex A (Operations Overlay).

A. Concept of the Operation. TF 1-10 conducts a forward passage of lines through TF 3-4 AR, 3rd BDE, 52 ID. We will then conduct a movement to contact using a battalion diamond formation to gain contact with the enemy and seize OBJ BRONZE, TIN, AND ZINC, O/O continue the attack to seize OBJ COPPER. My intent is to move rapidly, bypass smaller than platoon-sized elements and find the enemy. As he is withdrawing, I want to keep the pressure on and overrun him. Our objective is more to make and maintain contact than to seize terrain.

(1) Maneuver. TF 1-10 will move from the Assembly Area(AA) to the Line of Departure using routes Red and Black. Alpha Company will lead on Route Red, followed by CMD Group A, Team C, TF Trains. Team B will lead on Route Black followed by Heavy Mortars, Command (CMD) Group B, and D Company. The Scouts will cross the LD at 280400 SEP 2000 using both Route Red and Black to screen 3-5 kilometers (KM) forward of Alpha Company.

TF 1-10 will move in a battalion diamond with Alpha Company leading as Advance Guard. Alpha Company will be without attachments to aid in fast movement. Alpha Company must bypass units smaller than platoon size, report and bypass all obstacles. Team B will be on the western flank, Team C in the east and D Company trailing. When Alpha Company clears CP 12, the formation must be formed.

```
                    Team B
<---Scouts     Alpha Company          Mortars D Company
                    Team C
```

At OBJ BRONZE, Alpha Company will consolidate, orienting southeast. Team B will consolidate on OBJ TIN, orienting south/southeast, and Team C will consolidate on OBJ ZINC, orienting east/southeast. D Company will move to vic CP 15 as Battalion Reserve. Scouts screen along PL CARL.

O/O TF 1-10 continues movement to OBJ COPPER. Same formation will be used. Alpha Company seizes Check Point (CP) 10, Team B CP 4, and Team C CP 7. D Company consolidates at CP 13 as Reserve, Scouts screen along PL JOE.

(2) Fires. Annex B (Fire Support Overlay).
- a. TF 1-10 AR has priority of FA fires within the BDE.
- b. Priority of FA fires - Scouts, Alpha Company, Team B.
- c. Priority of Mortars - Team B, Team C, D Co.
- d. TF 1-10 has two Family of Scatterable Mines (FASCAMs) available. Bde C d r approval required for use.

(3) Engineering
- a. Priority of Effort (PoE) - Mobility (M), Counter-Mobility (CM), and Survivability (S)
- b. Priority of Mission (PoM) - Team B

(4) Air Defense Artillery (ADA)
- a. Weapon Control Status - Tight
- b. Air Defense Warning - Yellow
- c. Priority of Protection - D Co., Team B, TOC.

B. Subordinate Unit Instructions.

(1) Alpha Co. - at OBJ BRONZE, B/P to seize CP 15. At OBJ COPPER B/P to seize CP 4 and suppress CP 10.

(2) Team B - B/P to conduct obstacle breaches alone and as the TF breaching force. B/P to assume mission of advanced guard.

(3) Team C - B/P to assume mission of advanced guard.

(4) D Co. - At OBJ BRONZE, B/P to seize CP 18. At OBJ COPPER, B/P to seize CP 10.

(5) Scouts - B/P to assume flank guard mission to west.

(6) Mortars - Move behind Team B. At OBJ BRONZE, consolidate vic CP 14. At OBJ COPPER, consolidate behind D Co., at CP 13.

(7) ADA - Move with Team B throughout the operation. Ensure that Stinger Teams are positioned to support D Co., Team B, TOC, and TF Trains.

C. Coordinating Instructions.

(1) Priority Intelligence Requirements (PIR)
- a. Obstacle locations
- b. Report use of FST-1

(2) Mission Oriented Protective Posture (MOPP) Level 1 is in effect 280300 SEP 2000. MOPP 2 for personnel in the Brigade Support Area (BSA).

(3) Operational Exposure Guide (OEG) is 70 cGy.

4. SERVICE SUPPORT. Annex C.

5. COMMAND AND SIGNAL.

A. Command

(1) CMD Group A with Alpha Company.

(2) CMD Group B with Team B.

(3) Bn. TOC initial location is ES794984, subsequent locations ES778877, ES795815, ES845726.

(4) Alternate CP is Combat Trains CP.

(5) Succession of Command: Bn. XO, S-3, D Co. Cdr., B Co. Cdr., A Co. Cdr., and C Co. Cdr.

(6) Bde TOC located ET845008, then vic ES808915

B. Signal.

(1) Current Communications and Electronics Operating Instructions (CEOI) is in effect.

Acknowledge.

Bull
LTC, ARMOR

OFFICIAL:
Behringer
S-3

ANNEXES: Operations Overlay
Fire Support

CVCC EVALUATION
OFFENSIVE TEST SCENARIO

Company OPORD 2-90

1. Situation.

A. Enemy

(1) Overview: The 8th CAA, following a successful attack, has established a hasty defense (vic 91 E-W gridline) in order to establish lines of communication and supply with its rear area. Enemy contact has been lost throughout the sector. The 39th GMRD is believed to be in the 1st Bde. sector, with the 146th MRR (BMP) believed to be in the TF 1-10 sector.

(2) Composition and Disposition: The 39th GMRD consists of the 140th MRR (BTR), the 144th MRR (BTR), the 146th MRR (BMP) and the 79th TR. The overall strength of the division is 40-50%. The 140th and 144th MRRs are equipped with BTR-80s and the 146th MRR with BMP-2s. Tank battalions of the MRRs have T-80 tanks. The 79th TR is thought to have FST-1 tanks.

(3) Most Probable Course of Action: The 39th GMRD is economizing forces in a defensive belt in the vicinity of Elizabethtown (ES990710). The 146th MRR (BMP) is currently conducting a withdrawal to consolidate its defensive efforts vic Elizabethtown to the southeast. The 146th MRR will have covering forces deployed in the TF 1-10 sector of platoon sized and smaller elements. A rear guard consisting of a company (+) size element will probably be delaying in the vicinity of OBJ COPPER (850720).

B. Friendly.

(1) Team B - At OBJ TIN, consolidates, O/O seizes CP 4.

(2) Team C - At OBJ ZINC, consolidates, O/O seizes CP 7.

(3) D Co. - Consolidates vic CP 15 as TF Reserve. At OBJ COPPER, consolidates vic CP 13 as TF Reserve.

(4) Mortars - Move behind Team B. At OBJ BRONZE, consolidate vic CP 14. At OBJ COPPER, consolidate behind D Co. at CP 13.

2. MISSION. Alpha Company, 1-10 Armor, conducts a movement to contact at 280500 SEP 2000 to gain contact with enemy forces and seize OBJ BRONZE (ES800805), O/O, continue the attack southeast to OBJ COPPER (ES850720).

3. EXECUTION.

A. Concept of the operation. Alpha Company, TF 1-10, conducts a movement to contact along AXIS JAN using a company wedge formation to gain contact with the enemy and seize OBJ BRONZE, O/O continue the attack south to seize OBJ COPPER. My intent is to move rapidly, bypass smaller than platoon-sized elements and find the enemy. Our objective is more to make and maintain contact than to seize terrain.

(1) Maneuver. Alpha Company will move from the AA to the LD in a company column, platoons in column, along Route Red. Second Platoon will lead, followed by First and Third Platoons respectively. Second Platoon will cross the LD at 280500 SEP 2000. We will move in a company wedge, along AXIS JAN, bypassing units smaller than platoon size. First Platoon will be on the left, with Second in the middle, and Third on the right.

At OBJ BRONZE, First Platoon will consolidate vic ES808812, orienting southeast; Second Platoon vic ES805802, orienting south/southeast; Third Platoon vic ES854710, orienting south.

O/O, Alpha Company continues movement to OBJ COPPER. Same formation to be used. First Platoon will consolidate vic ES875710; Second Platoon vic ES872703; Third Platoon vic ES865702.

(2) Fires. Fire Support Overlay.

a. We are second in priority within TF, behind Scouts.

b. Priority of fires within the company is Second, First, and Third, respectively.

(3) Engineers.

a. POE - M, C/M, S

b. POM - Team B.

(4) Air Defense Artillery (ADA)

a. Weapon Control Status - Tight.

b. Air Defense Warning - Yellow.

c. Priority of Protection - D Co., Team B, TOC.

B. Subordinate Unit Instructions.

(1) First Platoon - at OBJ BRONZE, consolidate vic ES808812, at COPPER, vic ES875710.

(2) Second Platoon - at OBJ BRONZE, consolidate vic ES805802, at COPPER, vic ES872703.

(3) Third Platoon - at OBJ BRONZE, consolidate vic ES793803, at COPPER, vic ES865702.

C. Coordinating Instructions.

(1) PIR

a. Obstacle locations.

b. Report use of FST-1 tanks.

(2) MOPP Level 1 in effect 280300 SEP 2000, MOPP 2 for personnel in the BSA.

(3) OEG is 70 cGY.

4. SERVICE SUPPORT.

5. COMMAND AND SIGNAL.

A. Command.

(1) Co Cdr will be with Second Platoon.

(2) XO will be with Co. Trains.

(3) 1SG will be with Co. Trains.

(4) Succession of Command: XO, Second Plt, First Plt, Third Plt.

B. Signal.

* Current CEOI is in effect.

CVCC EVALUATION
OFFENSIVE TEST SCENARIO

SCENARIO EVENTS LIST

Reference: OPORD 2-90

Phase 0: Planning and Preparation

(T-2:00) Event 0.1: Co Cdr arrives and receives Bn. & Co OPORD.

Event 0.2 Controller/Bn. S3 issues Bn. OPORD to Co Cdr.

a. Complete five-paragraph order
b. Co Cdr is furnished with:
(1) Operations Overlay
(2) Fire Support Overlay
(3) Written Company OPORD
(a) Company graphics
(b) Company SOP as required

(T-1:30) Event 0.3: Co Cdr backbriefs the S3/Controller on the plan. It is important that this is monitored to ensure a standard operation for each test.

Event 0.4: Co Cdr issues order to Plt Ldrs.

a. During this time the Unit will conduct its Troop Leading Procedures. Battalion will not allow the physical conduct of rehearsals, but the Co Cdr can make use of map or terrain model rehearsals. All graphics will be disseminated throughout the company.
b. Platoon Leaders will backbrief the Co Cdr The S3/Controller must monitor these briefbacks to ensure that every leader has the proper concept.

Event 0.5: Unit is Initialized at Assembly Area.

(T-0:30) Event 0.6: Unit Conducts Pre-combat Checks and Prepares to Move.

* Pre-Combat checks include:
(1) Posting all graphics on a map and inputting graphics into onboard displays.
(2) Inputting waypoints for the driver.
(3) Checking all systems.
(4) Reports Readiness Condition (REDCON) 1 (C-B) before moving.

(T-0:15) Event 0.7: Unit is initialized in column formation near passage lane and marches to LD on Lane Red.

PHASE I: Unit Begins Movement To Contact, Seizes OBJ BRONZE.

Segment A: Unit Moves To Contact, Encounters MR Platoon

(T+0:00) Event 1: Unit crosses LD at the LD Time.

a. Plt. Ldrs. report LD crossing to Co Cdr

b. Co Cdr reports LD crossing to Bn.

Event 2: Unit encounters four destroyed vehicles.

a. ID - Unit correctly IDs the vehicles as dead and does not waste ammunition on them.

b. Co Cdr sends spot report (SPOTREP) on the sighting.

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Event 2.1: Non-flagged Radio Traffic

"Y02, this is S11, CONTACT, vic. ES740890, BMPs, moving to cover, out."

"Y02, this is S11, SPOTREP, Enemy BMPs, infantry, location vic. ES7489, attacking, I am pinned down, over."

"S11, this is Y03, Indirect Fire on the way, High Explosive/Variable time (HE/VT) and Smoke. Attempt to break contact and bypass."

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

(T+:05) Event 3: Company receives Intelligence report (Intelrep) Update and Orders

a. Intelrep Update (B-C-P-T) - "A06, this is Y03, scouts have identified minefield at ES748895 to ES751892 and two BMPs at ES749879, Y02 believes them to be a platoon-sized covering force. Attack to destroy this unit.

b. Co Cdr passes on this information, and issues a Company FRAGO to attack Motorized Rifle (MR) platoon.

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Segment B: Unit Encounters and Destroys Enemy MR Platoon

(T+:10) Event 1: Enemy MR Plt observes unit

a. Unit receives Indirect Fire.

b. Unit sends Shell Report (SHELLREP).

Event 2: Unit Fights Enemy

a. Unit receives Direct Fire from MR Plt vic. CP 12.

b. Unit sends CONTACT Report - three BMPs.

c. Unit engages MR Plt with direct and indirect fire.

(1) Unit sends SPOTREP

(2) Co Cdr sends Call for Fire (CFF).

(3) Unit avoids minefield

(4) Unit observes Blue Forces (BLUFOR) Scout vehicles vic. the minefield; does not engage them Identification Friend or Foe (IFF).

(5) Unit destroys MR Platoon. Sends SPOTREP, continues mission.

(T+:25) Event 3: Unit Crosses PL JIM.
a. Co Cdr reports crossing time.
b. Unit is observed by Enemy.
(1) Unit receives Indirect Fire.
(2) Unit sends SHELLREP.
c. Unit fights to seize OBJ BRONZE.
(1) Enemy engages with direct and indirect fire.
(2) Unit conducts hasty attack using fire and maneuver.
(3) Unit sends CONTACT Report.
(4) Co Cdr sends CFF.
(5) Unit sends SPOTREP.
(a) WHAT - Tank Platoon/3 tanks.
(b) WHERE - ES775842
(c) ACTIVITY - Hasty Defense
(d) Unit location/activity (continuing mission).
(6) Unit sends SPOTREP.
(a) WHAT - MR Plt/3 BMPs.
(b) WHERE - ES762828
(c) Hasty Defense.
(d) Unit location/continuing mission.
(7) Unit sends SPOTREP.
(a) Enemy Trains/2 fuel, 2 ammo trucks, 1 rec vehicle, 1 tank.
(b) OBJ BRONZE.
(c) Conducting resupply.
(d) Continuing mission.

Segment C: Consolidation and Reorganization.

(T+:45) Event 1: Unit consolidates and reorganizes on OBJ BRONZE, vic. CP 15.

Event 2: Unit sends SITREP.
a. Unit location.
b. Activity.
c. Ammo status.
d. Fuel Status.
e. Equipment Status.
f. Personnel Status.

Event 3.5: Nuclear, Biological, Chemical (NBC) Incident.
a. The SAFOR operator drops two volleys of artillery vic ES8280. The SAFOR operator calls A11 on 1st Plt frequency and reports: "A11, this is A14, SHELLREP. Observed ten rounds arty at ES8280." SAFOR operator waits until acknowledged, or until one minute

passes, and then continues: "A11, this is A14, follow-up to SHELLREP, observing a gaseous mist vic of arty impacts at ES8280." Wait one minute, then: "A11, this is A13, have identified gas as "VX" Nerve Agent, using M8 paper and M256."

b. Unit sends NBC-1 Report:

(1) BRONZE (location of unit).
(2) Grid (or Magnetic) 1600-2400 mils.
(3) Time Attack Started.
(4) Time Attack Ended.
(5) Location of attack: ES8280.
(6) Means of delivery Artillery.
(7) Agent: Nerve.
(8) No. of shells: 10.

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

---BREAK---

PHASE II: Unit Receives FRAGO to Move To, Seize OBJ SILVER.

(T+1:00)

Segment A: Unit Receives FRAGO #1

Event 1: FRAGO #1 TO OPORD 9-20

a. Para. 1: TF 1-91 HAS BEEN HELD ON OUR EASTERN FLANK NEAR PHASE LINE JIM. AN ENEMY TANK CO (+) IS WITHDRAWING TO THE SOUTHEAST.

b. Para. 2: MOVE TO CONTACT AT OBJ SILVER TO DESTROY WITHDRAWING ENEMY UNIT.

c. Para. 3a: AREA OF OPERATIONS (AO):

(1) BOUNDARIES: NE-Road Junction (RJ)ES946804
SE-RJ ES929742
NW-RJ ES830831
SW-RJ ES802781
(2) WEST BOUNDARY IS PL PAULA
(3) EAST BOUNDARY IS PL MIKE
(4) PL PAM IS ROAD ES878821 TO ES843769
(5) CP 20 - RJ ES847790
(6) CP 21 - HILLTOP ES874788
(7) CP 24 - RJ ES8978
(8) CENTER MASS OBJ SILVER - ES905784.

d. Para. 3b.: ALPHA CO LEADS BATTALION DIAMOND AS ADVANCED GUARD. TM. B FOLLOWS ON S. FLANK, TM C IN THE NORTH, AND D CO TRAILING. ALPHA CO CROSS LD AT (T+1:15) AND MOVES THROUGH CP 20 AND 21 TO SEIZE CP 24.

Event 2: Co Cdr issues Co FRAGO and movement instructions.
* Co Cdr orders Co to move out.

(T+1:15) Event 3: Unit crosses PL PAULA.
a. Co Cdr reports crossing PL PAULA.

(T+1:20)

Segment B: Unit Encounters Enemy En Route to OBJ SILVER.

Event 1: Enemy Plt at Hill 250 (vic ES874788) observes unit.
a. MR Plt engages Unit with indirect fire.
b. Unit sends SHELLREP.

Event 2: Intelrep Update received from Bn. Cdr. (Scouts).
a. "A06, this is Y03, scouts report minefield vic. ES876788 to ES879791. Also report two BMPs vic. ES874787."
b. Co Cdr notes this information, records it on paper or display, and passes it to his platoons.

Event 3: Unit crosses PL PAM, encounters MR Plt.

(T+1:30)
a. Unit reports crossing PL PAM, and crossing time.
b. Unit fights and destroys MR Plt.
c. Co Cdr sends CONTACT Report on three BMPs.
d. Co Cdr follows up CONTACT Report with SPOTREP:
(1) three BMPs, six howitzers
(2) vic. ES874787
(3) Hasty Defense
(4) Destroyed
(5) Unit location, continuing mission.
e. Radio Traffic: "A06, this is Y03, enemy tank company has passed the OBJ and is now vic ES9972. 1-10 ARMOR will consolidate on OBJ SILVER. New orders follow. Be prepared to move within ten minutes of receipt of orders. Send SITREP. Acknowledge, over."

(T+1:40)

Segment C: Consolidation and Reorganization.

Event 1: Unit Consolidates and Reorganizes on OBJ SILVER.

Event 2: Unit Reports
SPOTREP: Destroyed, two trucks, one recovery vehicle.

Event 3: Unit sends SITREP.
a. Unit location
b. Activity
c. Ammo status
d. Fuel status
e. Equipment status
f. Personnel status

---Break---

PHASE III: Unit Receives FRAGO #2, to Seize OBJ GOLD.

(T+1:45)

Segment A: Unit Receives FRAGO #2.

Event 1: FRAGO #2 to OPORD 9-20

a. Para 1: TF 1-91 HAS ELIMINATED RESISTANCE AT PL JIM AND IS READY TO CONTINUE MOVEMENT.

b. Para 2: 1-10 ARMOR CONDUCTS MOVEMENT TO CONTACT TO OBJ GOLD TO MAINTAIN PRESSURE ON WITHDRAWING ENEMY.

c. Para 3a: AREA OF OPS:

(1) BOUNDARIES:NW-Hilltop ES875788
NE-RJ ES914782
SE-RJ ES912690
SW-RJ ES842702

(2) NORTH BOUNDARY IS LD/PL TAMMY-ES875788-ES914782.

(3) SOUTH BOUNDARY OS LOA/PL LISA - ES842702-ES912690.

(4) CP 31 - ROAD BEND ES888753

(5) CP 32 - HILLTOP ES866732

(6) PL FORD ES911726 to ES852735

(7) CP 33 - HILLTOP ES883699

(8) CENTER MASS OBJ GOLD - ES880700

d. Para 3b: ALPHA CO LEADS BATTALION DIAMOND AS ADVANCED GUARD. TM B FOLLOWS ON WEST FLANK, TM C IN THE EAST, AND D CO TRAILING. ALPHA CO CROSSES LD MOVING WEST OF CP 31 AND THROUGH CP 32 TO SEIZE OBJ GOLD.

Event 2: Co Cdr posts FRAGO information to his map, and issues a Co FRAGO to Plts.

a. Co Cdr issues movement instructions and control measures (waypoints).

b. Co Cdr orders company to move out.

(T+2:00) Event 3: Company passes PL TAMMY.

a. Unit reports crossing PL TAMMY.

b. Unit encounters dead vehicles.

(1) Unit sends SPOTREP.

(2) Unit correctly IDs vehicles as dead (Does not engage them).

c. Unit passes PL FORD, reports doing so.

(T+2:05)

Segment B: Unit Moves To, Fights For OBJ GOLD.

Event 1: Unit Encounters Enemy Plt.

a. Unit receives Indirect Fire.

b. Unit sends SHELLREP.

c. Unit comes under Direct and Indirect Fire.

(1) Unit sends CONTACT Report.

(2) Co Cdr sends CFF.

(3) Unit engages Enemy with direct and indirect fire, attacks by fire and maneuver to destroy enemy.

d. Co Cdr follows up CONTACT Report with SPOTREP:

(1) Destroyed three tanks

(2) Location

(3) Hasty Defense

(4) Unit location and activity/ continuing mission.

Event 2: Unit Receives Orders.

"A06, this is Y03, an Enemy counterattack of tank battalion (+) size is reported heading north toward OBJ GOLD. Maintain hasty defense at OBJ GOLD and defeat this counterattack."

(T+2:25) Event 3: Unit Consolidates and Reorganizes on OBJ GOLD.

* Unit sends SITREP:

(1) Unit Location

(2) Activity

(3) Ammo Status

(4) Fuel Status

(5) Equipment Status

(6) Personnel Status

b. Unit prepares to defend OBJ GOLD.

(1) Co Cdr positions plts, designates plt sectors of fire.

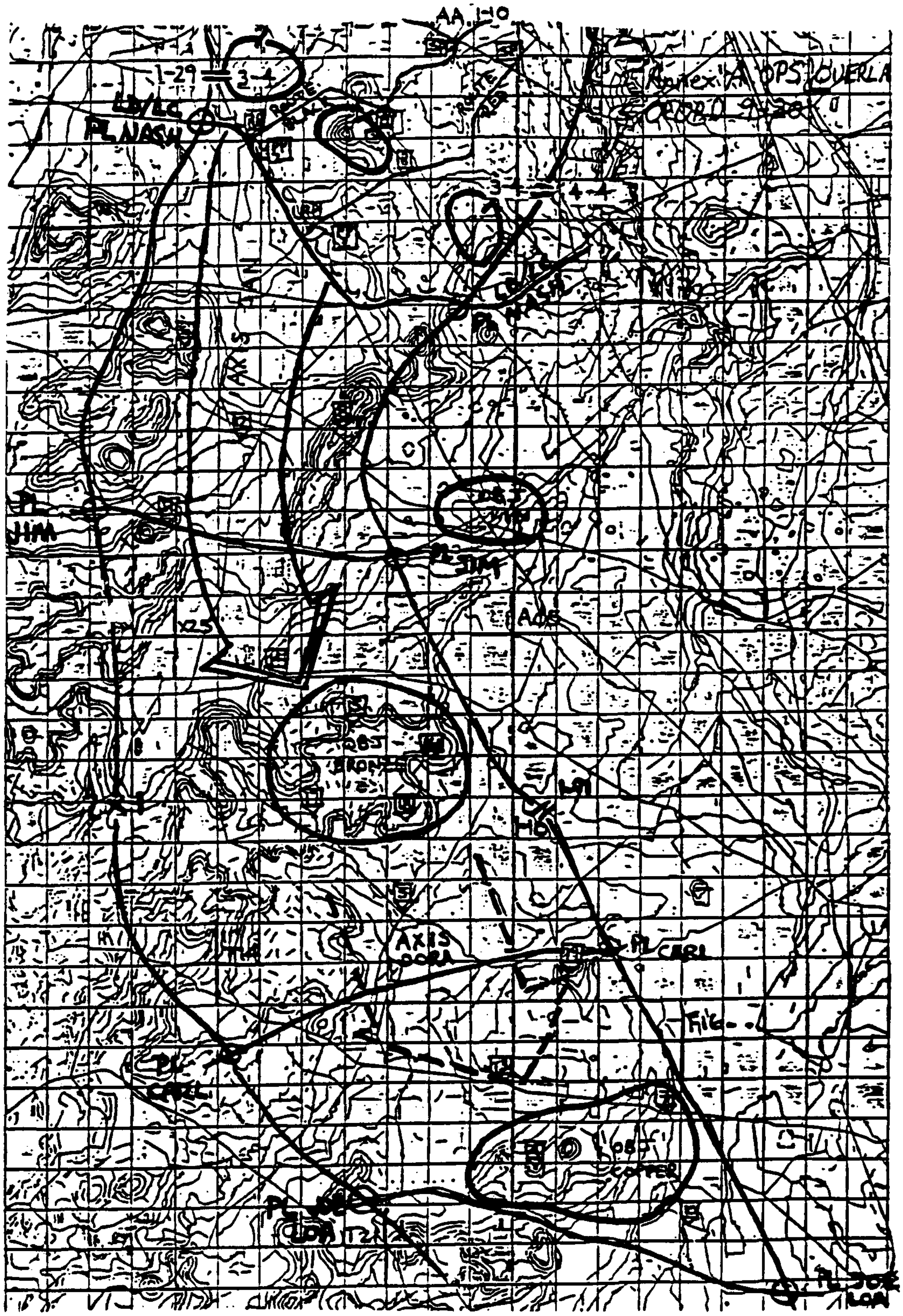
(2) Co Cdr designates engagement criteria.

(3) Plt Ldrs assign tank positions, sectors, and explain engagement criteria.

(T+2:30)

*********End of Exercise (ENDEX) **************************

---Situational Awareness Assessment---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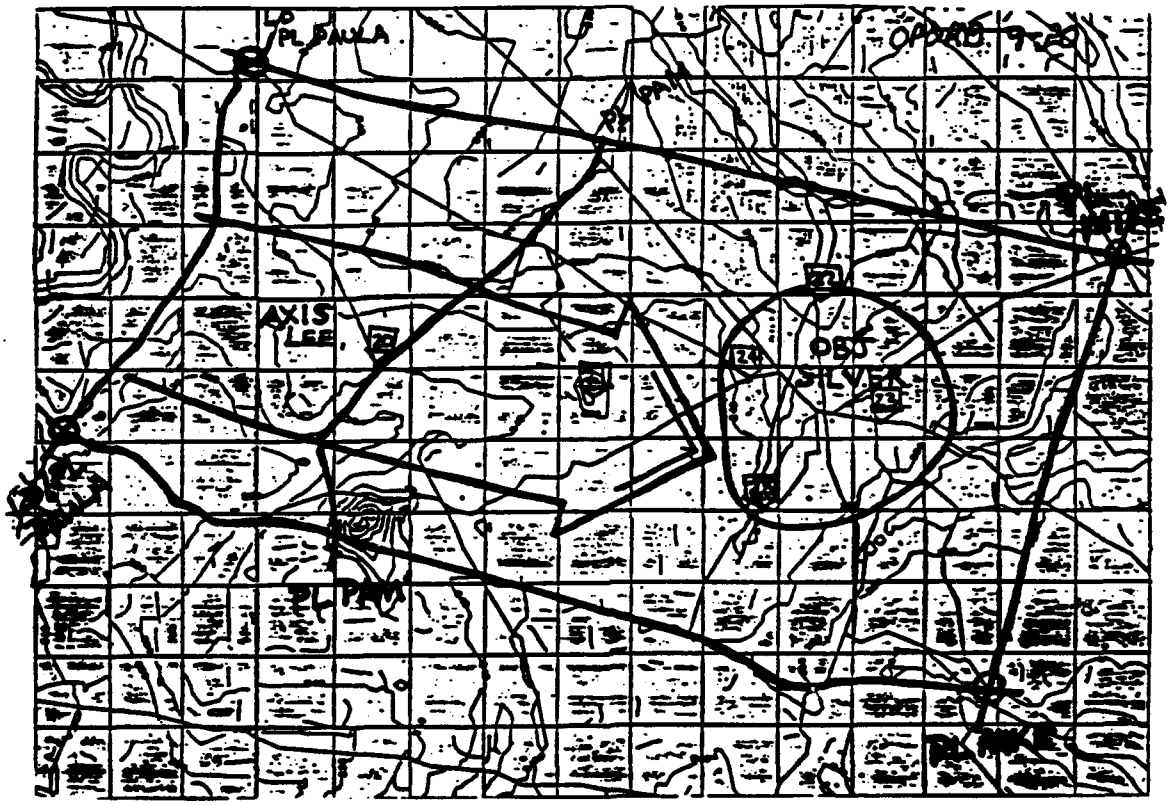
1-29
3-4
PL NASH
PL JIM
AXIS
PL CARL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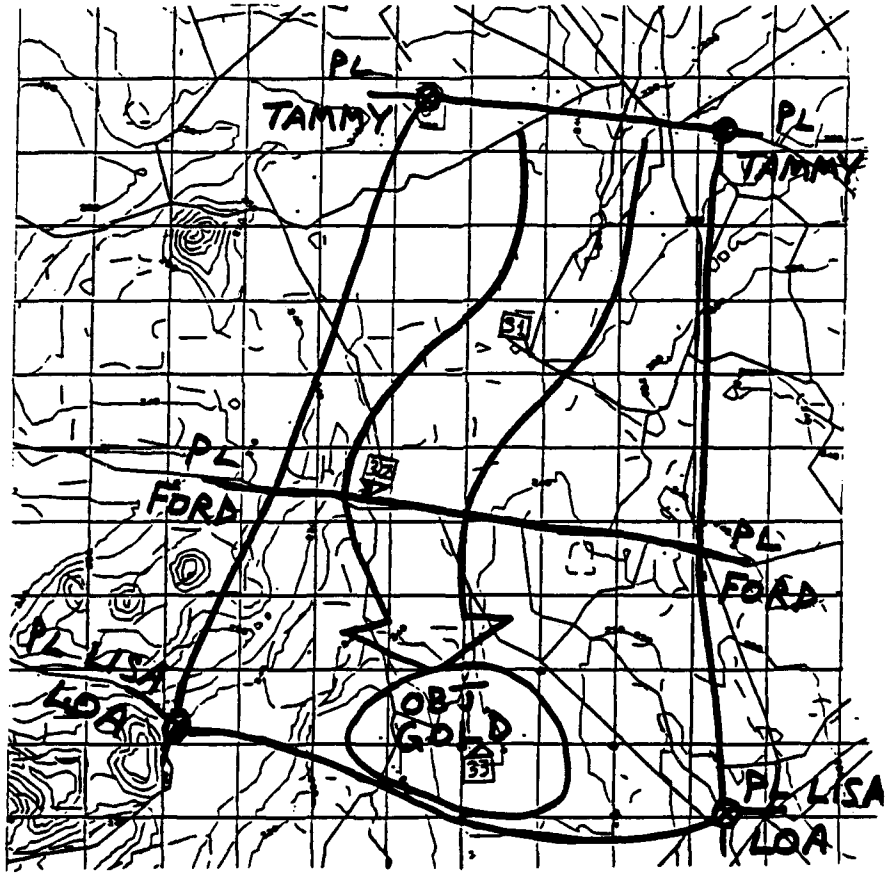
PL
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Appendix A-B

Defensive Test Tactical Scenario Materials

The table of contents for Appendix A-B, the Defensive Test Tactical Scenario Materials, is as follows:

CVCC EVALUATION
DEFENSIVE TEST SCENARIO

Battalion OPORD 2-89

Copy ____ of ____ Copies
TF 1-10 AR, 1st BDE, 23AD
ES 795974
270800 SEP 2000

REFERENCES: Map Series V753, V751 Kentucky-Indiana, Sheets M3753 I, II, III, IV; M3760 II, III, Edition 1-AMS, 1:50,000.

Time Zone Used Throughout the Order: Romeo.

Task Organization:

TM B, 1-10 AR	Alpha Co, 1-10 AR
B Co, 1-10 AR (-)	
1/C/1-92 Mechanized (Mech)	
TM C, 1-92 Mech	D Co, 1-10 AR
C Co, 1-92 Mech (-)	
1/B/1-10 AR	
TF Control	TF Trains
Bn Scout Plt	MST/B/1 FSB
Bn Heavy Mortar Plt	
1/A/1-244 ADA(V/S)	

1. SITUATION

A. Enemy:

(1). Overview: The 8th CAA has been attacking for the last 24 hours from SE to NW along the Elizabethtown-Brandenburg axis. The 52nd Infantry Division (Mechanized) (ID[M]) has stopped the first echelon divisions, the 4th Motorized Rifle Division (MRD) and the 17th MRD, just south of Elizabethtown. The commitment of the second echelon divisions of the 8th CAA has forced the withdrawal of the 52nd ID(M). The 39th GMRD and the 1st Guards Tank Division (GTD) are currently pursuing the 52nd ID(M). In our sector, we will face elements of the 39th GMRD.

(2). Composition/Disposition: The 39th GMRD consists of the 140th GMRR (BTR), the 144th GMRR (BTR), the 146th GMRR (BMP), and the 79th GTR. Both the 140th and the 144th GMRRs are equipped with BTR-80s. The 146th GMRR is equipped with BMP-2s. The 79th GTR is thought to be equipped with FST-1s. All of the GMRRs tank battalions are equipped with T-80s. The 140th and 144th GMRRs are thought to be the first echelon regiments of the 39th GMRD. They are currently pursuing the 52nd ID(M) vic ES950580 - ES080760 and are estimated to be at 90% strength. The 146th GMRR and 79th GTR are thought to be the 39th GMRD's second echelon and are estimated to be at 95% strength.

(3) Most Probable Course of Action: The 8th CAA will continue to attack for the next 24-36 hours to secure crossing site(s) over the Ohio River in order to pass the 18th CAA through to continue the attack north. The 39th GMRD will continue to attack along the Elizabethtown-Brandenburg axis for the next 24 hours and attempt to seize crossing sites vic ET820080. The enemy main effort will most likely be in the eastern portion of our sector, along Highway 31W.

B. Friendly:

(1) 1st BDE, 23AD: Delays in sector from 271400 SEP 2000 to 271800 SEP 2000 to slow the enemy advance, force the deployment of the second echelon regiments of the 39th GMRD and 1st GTD prior to PL Trump, and create the preconditions for the Division counterattack by 2nd BDE, 23AD. 1st Bde, 23 Armor Division (AD) assists with the RPoL and accepts Battle Hand Off (BHO) from 52nd ID(M) NLT 271400 SEP 2000.

(2) TF 1-92: Conducts delay in sector to slow the enemy advance and force the deployment of the 2nd echelon regiments of the 1st GTD prior to PL Trump. O/O assists Division counterattack by 2nd BDE.

(3) 210 ACR conducts delay in sector to screen the Corps eastern flank.

(4) 1st BDE, 52nd ID(M) conducts withdrawal and BHO at PL King and executes Rearward Passage of Lines (RPoL) through TF 1-10 AR Not Later Than (NLT) 271400 SEP 2000.

(5) 1-91 Mech prepares defensive positions vic PL Trump. O/O becomes BDE reserve.

(6) 1-50 FA(155SP) DS to 1st BDE, 23AD. 1-51 FA(155SP) GSR to 1-50 FA. PoF are initially to TF 1-10 AR, O/O to TF 1-92 Mech.

(7) A/23rd ENG DS to 1st BDE, 23AD.

(8) A/1-244 ADA(V/S) DS to 1st Bde, 23AD.

(9) 8th Tactical Air Force (TAF) supports 1st BDE, 23AD with eight sorties. All sorties are under BDE control.

C. Attachments - see Task Organization.

2. MISSION: TF 1-10 AR conducts delay in sector from 271400 SEP 2000 to 271800 SEP 2000 to slow the enemy advance and force the commitment of the second echelon regiments of the 39th GMRD south of PL Trump. TF 1-10 AR accepts BHO from and assists in the RPoL of 1st BDE, 52nd ID(M) NLT 271400 SEP 2000 at PL King. O/O conduct RPoL through 1-91 Mech.

3. EXECUTION:

A. Concept of the Operation: TF 1-10 AR will conduct a delay in sector in three phases. Phase I - Cover the Battle Hand Off Lines (BHOL) with three Co/Tms in BPs 10, 20, and 30. Accept BHO and assist in the RPoL of 1st BDE, 52nd ID(M) at PL King. Heavily attrit the first echelon battalions between PL King and PL Club and determine the enemy's main effort. Phase II - Force the commitment of the second echelon by PL Spade. Phase III - Continue to attrit the enemy second echelon between PL Spade and PL Trump. O/O conduct BHO and RPoL through 1-91 Mech at PL Trump. My intent

is to hit the enemy as hard as possible at the BHOL, disrupt his pursuit, and heavily attrit his first echelon battalions. Then we will give ground to vic PL Club to determine the enemy's main effort. I then want us to keep constant contact with the enemy while avoiding decisive engagement and attrit him as heavily as possible throughout the remainder of the sector. We need to be ready to hold the high ground just south of PL Trump if the Division counterattack is launched early. We will prevent the enemy penetration of PL Trump for at least four hours.

(1) Maneuver:

a. Phase I - Alpha Co, Tm B, and Tm C will occupy Battle Positions (BPs) 10, 20, and 30 respectively and position at least two platoons forward to overwatch the BHOL. Scouts man Contact Points 1, 2, and 3 to coordinate RPoL with 1st BDE, 52nd ID(M) on Passage Lanes White and Gold. Scouts establish observation of enemy forces and follow 1st BDE, 52nd ID(M) through RPoL. Alpha Co, Tm B, and Tm C engage lead enemy forces in EAs Sting, Whip, and Chain. Cos will request permission to displace when enemy Co(+) closes within 1500 meters or enemy element of any size attempts to bypass respective BP. Cos will use internal overwatch to cover displacement within sector. Cos will not cross PL Club without permission. D Co is TF Reserve and occupies BP 40.

b. Phase II - Cos continue to delay in sector. Scouts establish Screen Line 1 along TF eastern boundary. B/P to occupy BPs 11, 21, and 31. D Co is TF Reserve and occupies BP 41. Cos will not cross PL Spade without permission.

c. Phase III - Cos continue to delay in sector. Scouts establish Screen Line Two. Be Prepared (B/P) to occupy BPs 12, 22, 32, and 41 and defend to retain. O/O establish contact with 1-91 Mech scouts at Contact Points 21, 22, and 23 and conduct BHO and RPoL through 1-91 Mech on Lanes Blue, Green, Orange, Yellow, Purple, and Black. O/O move to AA to become 1st BDE reserve.

(2) Fires (Fire Support Overlay):

a. TF 1-10 AR has priority of FA Fires within the BDE.

b. PoF(FA): Phase I - Scouts, Tm C, Tm B, Alpha Co, D Co; Phase II, III - Tm C, Tm B, Alpha Co, D Co, Scouts.

c. PoF(Mtrs): Phase I - Scouts, Alpha Co, Tm B, Tm C, D Co; Phases II, III - Alpha Co, Scouts, Tm B, Tm C, D Co.

d. Priority Fires: Tm C has one FA Priority Target in Phase I.

e. TF 1-10 AR has two FASCAM minefields available. FASCAM requires BDE Cdr's approval for use.

(3) Obstacles.

a. PoE: Tm C, Tm B, Alpha Co, D Co.

b. PoM: Phase I, II - C/M, S, M

(4) ADA:

a. WCS - Tight.

b. ADW - Yellow.

c. Priority of Protection - Phase I thru III: Reserve, TOC, Tm C, Tm B, Alpha Co.

B. Subordinate Unit Instructions:

(1) Tm B - Phase I: Occupy BP 20. Provide guides for Passage Lane Gold. Phase II: B/P to occupy BP 21. Phase III: B/P to occupy BP 22. B/P to conduct RPoL on Passage Lanes Orange and Yellow.

(2) Tm C - Phase I: Occupy BP 30. Provide guides for Passage Lane White. Phase II: B/P to occupy BP 31. Phase III: B/P to occupy BP 32. B/P to conduct RPoL on Passage Lanes Purple and Black.

(3) Alpha Co - Phase I: Occupy BP 10. Phase II: B/P to occupy BP 11. Phase III: B/P to occupy BP 12. B/P to conduct RPoL on Passage Lanes Blue and Green.

(4) D Co - Phase I-III: B/P to reinforce Tm C/Tm B sector once enemy's main effort is identified. B/P to conduct counterattack by fire to maintain integrity of the TF sector.

(5) Scouts - Phase I: Establish Contact Points 1, 2, and 3 NLT 271200 SEP 2000. Priority of FA/Mortar Fires until RPoL. Consolidate at CP 10 following RPoL. Phase II: Establish Screen Line 1. Phase III: Establish Screen Line 2.

(6) Mortars - Phase I: Occupy Initial BP vic CP 17. B/P to operate split section to support TF delay. Phase II-III: Move under control of TF Fire Support Officer (FSO). B/P to coordinate own RPoL.

(7) ADA - Phases I-III: Provide one Stinger team to maneuver with Tm C, Tm B, TOC, D Co, Trains. Vulcan Platoon maneuvers with Tm B.

D. Coordinating Instructions:

(1) PIR

a. Report sightings of FST-1s.

b. Report any use of chemical munitions.

c. Report any airmobile operations.

(2) Priority of Friendly Information

a. Report BHO from 1st BDE, 52nd ID(M) at PL King and initial enemy contact.

b. Report commitment of second echelon regiments of 39th GMRD.

c. Report any penetrations of Plt size or greater at all phase lines (PLs).

d. Report crossing all PLs.

(3) No Infantry Forces south of PL King until after BHO is complete.

(4) Forward Co/Tms establish alternate Passage Lanes to support RPoL of 1st BDE, 52nd ID(M).

(5) Recognition symbol for RPoL is orange panel marker on the front of the vehicle during the day, red flashlight at night.

(6) OEG is 70 cGy. Report at 5cGy.

(7) MOPP level 1 is in effect NLT 271300 SEP 2000.

(8) Disengagement criteria: Motorized Rifle Company (MRC) elements within 1500 meters, or an enemy element of any size attempting to bypass a BP.

4. SERVICE SUPPORT. Annex C.

5. COMMAND AND SIGNAL

A. Command

(1) CMD Group A will be with Tm B.

(2) CMD Group B will be with Alpha Co.

(3) Bn TOC initial location ES873926, subsequent location ES851947.

(4) Alternate CP is Combat Trains CP.

(5) Succession of Command: Bn XO, S-3, D Co Cdr, Tm B Co Cdr, Alpha Co Cdr, Tm Co Cdr.

B. Signal

(1) Current CEOI is in effect.

Acknowledge.

Jones
LTC, ARMOR

OFFICIAL:
Behringer
ASST S3

Enclosures:
Operations Overlay
Fire Support Overlay

CVCC EVALUATION
DEFENSIVE TEST SCENARIO

Company OPORD 2-89

1. SITUATION

A. Enemy:

(1) Overview: The 8th CAA has been attacking for the last 24 hours from SE to NW along the Elizabethtown-Brandenburg Axis. The 39th GMRD and the 1st GTD are currently pursuing the 52nd Infantry Division (Mechanized) [ID(M)]. In our sector, we will face the 39th GMRD.

(2) Composition/Disposition: The 39th GMRD consists of the 140th GMRR(BTR), the 144th GMRR(BTR), the 146th GMRR(BMP), and the 79th GTR. Both the 140th and the 144th GMRRs are equipped with BTR-80s. The 146th GMRR is equipped with BMP-2s. The 79th GTR is thought to be equipped with FST-1s. All of the GMRRs tank battalions are equipped with T-80s. The 140th and 144th GMRRs are thought to be the first echelon regiments of the 39th GMRD. They are currently pursuing the 52nd ID(M) vic 03 EW gridline and are estimated to be at 90% strength. The 146th GMRR and 79th GTR are thought to be the 39th GMRD's second echelon, and are estimated to be at 95% strength.

(3) Most Probable Course of Action: The 8th CAA will continue to attack for the next 24-36 hours. The enemy main effort will most likely be in the eastern portion of our sector, along Highway 31W. They will attack two up, one back, until they achieve success, where they will attack on line. We can expect to see the enemy using limited recon assets. Friendly scouts and Armored Cavalry Regiments (ACRs) have been successful in the counterrecon battle and have stripped away the enemy recon so that we can expect to see the Opposing Forces (OPFOR) in prebattle formations.

B. Friendly:

(1) TF 1-10 AR conducts a delay in sector from 271400 SEP 2000 to 271800 SEP 2000 to slow the enemy advance and force the commitment of the second echelon regiments of the 39th GMRD south of PL Trump. TF 1-10 AR accepts BHO from and assists in the RPoL of 1st BDE, 52nd Infantry Division (Mechanized) NLT 271400 SEP 2000 at PL King. O/O conduct RPoL through 1-91 Mech.

(2) TF 1-92 is on our right conducting a delay in sector.

(3) Tm B is on our left occupying BP 20.

(4) D Co is to our rear with the primary mission of reinforcing Teams B and C.

C. Attachments: None.

2. MISSION: A/1-10 AR conducts a delay in sector from 271400 SEP 2000 to 271800 SEP 2000 at BP 10 to slow the enemy advance and force the commitment of the second echelon regiments of the 39th GMRD south of PL Trump. A/1-10 AR accepts BHO from and assists in the RPoL of 1st BDE, 52nd ID(M) NLT 271400 SEP 2000 at PL King. O/O conduct RPoL through 1-91 Mech.

3. EXECUTION:

A. Concept of the Operation: A/1-10 AR will conduct a delay in sector in three phases. Phase I - Cover the BHOL at BP 10. Accept BHO and assist in the RPoL of 1st BDE, 52nd ID(M) at PL King. Phase II - Force the commitment of the second echelon by PL Spade. Phase III - Continue to attrit the enemy second echelon between PL Spade and PL Trump. O/O conduct BHO and RPoL through 1-91 Mech at PL Trump. My intent is to hit the enemy as hard as possible at the BHOL, disrupt his pursuit, and heavily attrit his first echelon battalions. Then we will give ground to vic PL Club to determine the enemy's main effort. I want us to keep constant contact with the enemy while avoiding decisive engagement and attrit him as heavily as possible throughout the remainder of the sector. We need to be ready to hold the high ground just south of PL Trump if the Division counterattack is launched early. We will prevent the enemy penetration of PL Trump for at least four hours.

(1) Maneuver:

a. Phase I - Alpha Co will occupy BP 10 (vic ES879796) to overwatch the BHOL. 1st Platoon will be on the left (BP 131, vic ES889800), 2nd Platoon in the middle (BP 121, vic ES879796), and 3rd Platoon on the right (BP 111, vic ES873786). Alpha Co engages lead enemy forces in Engagement Area (EA) Sting. We will request permission to displace when enemy Co(+) closes to within 1500m or enemy element of any size attempts to bypass our BP. We will use internal overwatch to cover our displacement within sector to BP 11 (vic ES835878) and BP 12(vic ES820910). 2nd Platoon will initially overwatch 1st and 3rd Platoons' displacement to BPs 132 (vic ES876820) and BP 112 (vic ES842825) respectively. 1st and 3rd Platoons will then overwatch 2nd Platoon's displacement to BP 122 (vic ES862849). We will not cross PL Club without permission.

b. Phase II - Alpha Co continues to delay in sector. B/P to occupy BP 11. 2nd and 3rd Platoons will overwatch the displacement of 1st Platoon to BP 133 (vic ES846887). 1st and 2nd Platoons will then overwatch the displacement of 3rd Platoon to BP 113 (vic ES835868). 1st and 3rd Platoon will then overwatch the displacement of 2nd Platoon to either BP 11 (vic ES835878) or BP 123 (vic ES823913), depending on the situation. Alpha Co will not cross PL Spade without permission.

c. Phase III - Alpha Co continues to delay in sector. B/P to occupy BP 12 (as specified in Phase I above) and defend to retain. 1st and 3rd Platoons will overwatch the displacement of 2nd Platoon to BP 123 (vic ES823913). 1st and 2nd Platoons will then overwatch the displacement of 3rd Platoon to BP 114 (vic ES812901). 2nd and 3rd Platoons will then overwatch the displacement of 1st Platoon to BP 134 (vic ES835922). O/O 2nd and 3rd will send one tank each to establish contact with 1-91 Mech scouts at Contact Point 21. 3rd Platoon will conduct BHO and RPoL through 1-91 Mech on Lane Blue. 1st and 2nd Platoons will move on Lane Green. O/O move to Assembly Area (AA) (to be specified).

(2) Fires:

a. PoF(FA): Phase I - Alpha Co is fourth in priority. Phases II and III - Alpha Co is third in priority.

b. PoF (Mtrs): Phase I - Alpha Co is second in priority. Phases II and III - Alpha Co has priority of fires.

c. PoF within company is 2, 1, 3.

(3) Obstacles:

a. PoE: Alpha Co is third in priority.

b. PoM: Phase I, II - C/M, S, M. Phase III - C/M, S, M; O/O S, C/M, M, at PL Trump.

(4) ADA

a. WCS - Tight.

b. ADW - Yellow.

c. Priority of Protection - Phase I-III: Alpha Co. is fifth in priority.

B. Subordinate Unit Instructions:

(1) 1st Platoon:

a. Occupy BP 131 (vic ES889800).

b. O/O displace to BP 132 (vic ES876820) using maneuver technique described above.

c. O/O, displace to BP 133 (vic ES846887).

d. O/O, displace to BP 134 (vic ES835922).

(2) 2nd Platoon:

a. Occupy BP 121 (vic ES879796).

b. O/O displace to BP 122 (vic ES862849) using maneuver technique described above.

c. O/O, displace to BP 123 (vic ES823913).

d. O/O at BP 123, send one tank to link up with Scouts from TF 1-91 at Contact Point 21 (vic ES809915).

(3) 3rd Platoon:

a. Occupy BP 111 (vic ES873786).

b. O/O displace to BP 112 (vic ES842825) using maneuver technique described above.

c. O/O, displace to BP 113 (vic ES834868).

d. O/O, displace to BP 114 (vic ES812901).

e. O/O at BP 114, send one tank to link up with Scouts from TF 1-91 at Contact Point 21 (vic ES809915).

D. Coordinating Instructions:

(1) PIR

a. Report sightings of FST-1s.

b. Report any use of chemical munitions.

c. Report any airmobile operations.

(2) Priority of Friendly Information.

a. Report BHO from 1st BDE, 52nd ID(M) at PL King and initial enemy contact.

b. Report commitment of second echelon regiments of 39th GMRD.

c. Report any penetrations of plt size or greater at all PLs.

d. Report crossing all PLs.

(3) No Indirect Fire south of PL King until after BHO is complete.

(4) Recognition symbol for RPoL is orange panel marker on the front of the vehicle during the day, red flashlight at night.

(5) OEG is 70 cGy. Report at 5 cGy.

(6) MOPP Level One is in effect NLT 271300 SEP 2000.

(7) Disengagement criteria: MRC(+) elements within 1500 meters, or enemy element of any size attempts to bypass a BP.

4. SERVICE SUPPORT (per SOP).

5. COMMAND AND SIGNAL.

A. Command

(1) Co Cdr will be with 2nd Plt.

(2) Bn Cdr is with Tm B.

(3) Succession of Command: XO, 2nd Plt Ldr, 1st Plt Ldr, 3rd Plt Ldr.

B. Signal

* Current CEOI is in effect.

CVCC EVALUATION
DEFENSIVE TEST SCENARIO

SCENARIO EVENTS LIST

Reference: OPORD 2-89

Phase 0: Preparation for operation.
General: Unit leaders are issued OPORD, unit personnel prepare simulators for operation. Unit sub-leaders issue OPORDS. Unit is initialized near its initial battle position.

(T-2:00) Event 0.1 Co Cdr arrives and receives Bn & Co OPORD.
Event 0.2: Controller/Bn S3 issues Bn OPORD to Co Cdr.
a. Complete five-paragraph order.
b. Co Cdr is furnished with:
(1) Operations Overlay.
(2) Fire Support Overlay.
(3) Written Company OPORD.
(a) Company graphics.
(b) Company Standard Operating Procedure (SOP) as required.

(T-1:30) Event 0.3: Co Cdr backbriefs the S3/Controller on the plan. It is important that this is monitored to ensure a standard operation for each test.

(T-1:15) Event 0.4: Co Cdr issues order to Plt Ldrs.
a. During this time the unit will conduct its Troop Leading Procedures. Battalion will not allow the physical conduct of rehearsals, but the Co Cdr can make use of map or terrain model rehearsals. All graphics will be disseminated throughout the company.
b. Platoon Leaders will backbrief the Co Cdr The S3/Controller must monitor these briefbacks to ensure that every leader has the proper concept.

Event 0.5: Unit is Initialized at Initial Battle Position.

(T-0:30) Event 0.6: Unit conducts pre-combat checks and prepares to defend BP 10.

Phase I: Defense of BP 10.
Segment A: Occupation and Preparation of BP 10.

(T+0:00) Event 1: Unit occupies and prepares BP 10.
a. Intel Update (B-C-P-T) - Scouts report contact with elements of 1st BDE, 52nd ID(M). They are under heavy enemy (EN) pressure and withdrawing rapidly with the EN in full pursuit. They are currently along a line from ES870775 - ES974817 and will be conducting a rearward passage of lines through our sector within the next 30 minutes. They have

identified elements of the 144th and 146th MRRs pushing NW from Elizabethtown grid ES900720 towards our sector. Expect contact during or immediately following the passage of lines.

b. Unit prepares range cards (T-P-C-B).

c. Reports: SITREP

(1) Location - ES875800 (center/mass)

(2) Activity - defending

(3) LOG status

(T+0:10) Event 2: Unit assists BLUFOR RPoL

a. Intel Update (B-C-P-T) - Elements of 1st BDE, 52nd ID(M), conducting Rearward Passage of Lines through Tm B and Tm C on Lanes White and Gold. Scouts report 2-3 MRBs moving in Co. columns vic ES905744, ES952760, and ES974756. Identify T-64s and BMP-2s.

b. FRAGO (B-C-P-T) - Scout section 1 will move through your BP on new lane, designated LANE SILVER (ES905783-ES871804) in five minutes.

c. Scout section 1 moves through BP 10.

d. Intel Update (B-C-P-T) - Scouts identified two or more MRB-sized units moving into our sector from the SE.

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Event 3: Non-flagged Radio Traffic Generated by BattleMaster

"Y03, this is B06, I have encountered heavy enemy pressure. I am now in contact with four MRCs plus. Continuing to engage. Out."

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Segment B: Unit Defends BP, Destroys OPFOR, Reports.

(T+0:15) Event 1: Reports:

a. CONTACT - Enemy tanks, BMPs; location (ES895770).

b. SPOTREP - Type (tanks, BMPs), Location (see above), Number (20-25), Activity (attacking).

Event 2: Unit engages 20-25 Enemy tanks/BMPs (2 MRCs plus). Bn calls for SITREP.

Event 3: At disengagement line, Co Cdr requests permission to displace to subsequent BPs. Bn gives permission to displace.

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Non-flagged Radio Traffic Generated by BattleMaster

"Y03, this is B06, I have lost three vehicles. Request permission to displace. Over."

"B06, this is Y03, roger, displace now. Out."

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Segment C: Unit Conducts Disengagement and Displacement.

(T+0:35) Event 1: Co Cdr orders platoons to displace to subsequent battle positions. Platoons displace as ordered.

a. 2nd Platoon moves to BP 132, reports SET when in position.
b. 1st and 3rd Platoons move simultaneously to BPs 112 & 122 respectively. Both report SET when ready.
c. 2nd Platoon receives Indirect Fire, reports with a SHELLREP.

Event 2: Co Cdr reports SET to Bn when Company is set in position.

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Non-flagged Radio Traffic Generated by Bn

"C06, this is Y03, Displace now. Report REDCON ONE prior to moving send SITREP. Out."

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IFF/Unit Continues to Engage Enemy Stragglers, Does Not Engage BLUFOR.

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(T+0:50) Event 3: NBC Incident

"A31 this is A34 , GAS,GAS,GAS. I have just observed 6 artillery rounds impact. Break, M-8 paper has reacted. Enemy personnel are masked, and those that are not are dropping to the ground in convulsions."
Unit. (P-C-B) Unit submits NBC-1 Report.

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---Break---

Phase II: FRAGO #1 To BP 14

Segment A: Unit Receives FRAGO and Moves.

(T+0:55) Event 1: Unit Receives FRAGO.

a. FRAGO #1 (B-C-P-T) - "En MRB (+) has pushed Tm B back to vic CP 11. Bypassed Tm B tank reports En Tank Co.(+) moving SE to NW towards your sector vic ES913824. Move to BP 14 (ES860850-860870-868853-866873) ASAP. Orient E/SE, prevent En from crossing the river or seizing the road junction vic ES870861. Ensure you maintain contact with the En in your sector. Report when set."
b. Co Cdr acknowledges receipt of FRAGO, issues movement orders/locations for Plts.

(T+1:00) Event 2: Unit Moves to BP 14.

a. The bulk of the company moves through the vic of CP9.

b. When in BP 14, Co Cdr reports set to report location (Set in BP 14), activity (Defending), Logistics Status.

Event 3: IFF - As Unit Moves and Sets at BP 14, It Does Not Engage Friendly Stragglers.

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Event 3.5: Non-flagged Radio Traffic Generated by BattleMaster

"A06, this is Y03, B06 receiving pressure. You have control in your Area of Operations. Keep me informed. Out."

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Segment B: Unit Defends BP 14 Against OPFOR Tk. Co. From SE.

Event 1: Reports

a. CONTACT - tanks, SE, (vic ES890852)

b. SPOTREP - Type (tanks/BMPs), Location (see above), Number (10-14), Activity (Attacking)

(T+1:10) Event 2: Unit Engages OPFOR With Direct and Indirect Fire.

a. Co Cdr gives Call For Fire.

b. Co Cdr issues Co Fire Command (Cmd).

c. Plt Ldrs issue Plt Fire Cmds.

d. Unit receives Indirect Fire, sends SHELLREP.

Event 3: Unit Comes Under OPFOR Air Attack

a. CONTACT Report: choppers, SE (vic ES890852).

b. SPOTREP - Type (Hind-D/M24s), Location (see above), Number (2), Activity - (Attacking).

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Event 3.5: Non-flagged Radio Traffic

"Y03, this is B06, I am now observing three MRCs plus at 3000 meters. Preparing to engage. Over."

"B06, this is Y03, roger. Out."

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Segment C: Unit Receives Pressure From the South.

(T+1:15) Event 1: Reports

a. CONTACT, BMPs, South (vic ES867827).

b. SPOTREP, Type (BMPs), Location (see above), Number (6), Activity (Attacking).

Event 2: Unit Engages OPFOR.

a. Co Cdr (or Plt Ldr for S sector) gives CFF.

b. Unit destroys OPFOR by fire.

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Non-flagged Radio Traffic

"Y03, this is B06, I have lost two vehicles. We have stopped two MRCs. Request permission to displace. Over."

Non-flagged Radio Traffic

"B06, this is C06, I have your remaining MRC in sight. Am engaging. Out."

Non-flagged Radio Traffic

"Y03, this is B06. My situation is now stable. Enemy appears to have halted, Over."

"B06, this is Y03, roger, Out."

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(T+1:25) Event 3: Unit Prepares to Continue Defense.

a. Intel Update (B-C-P-T) - It appears that the Enemy first echelon units have halted and are going into a hasty defense. Bde reports Enemy second echelon forces moving forward to continue the attack.
All elements submit SITREPs and continue to Delay in Sector back to PL SPADE. Bde engineers have finished emplacing Ground Emplaced Mine Scattering System (GEMSS) minefield from ES807892 to ES813901.

b. Co Cdr sends SITREP to Bn.
(1) Location - BP 14
(2) Activity - Continuing mission
(3) Logistics (LOG) Status

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Non-flagged Radio Traffic

"Y03, this is L06 (Bde. Cdr.), your push, break---We have second echelon in sector. Meet L03 on my push. Out."

Break/Situational Awareness Assessment

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Phase III: Unit Receives FRAGO #2 to Defend BP 13.

Segment A: Unit Receives FRAGO #2 and Moves to BP 13.

(T+1:35) Event 1: FRAGO #2 - Bde reports En main effort shifting W along Highway 91 (ES870861 - ES794928). The Bn is shifting its entire sector W to prevent En penetration of PL TRUMP and to hold the high ground just south of PL TRUMP. TF Rear Boundary is PL TRUMP. Forward Boundary is PL SPADE. Western Boundary is ES761916 to ES814874. Eastern Boundary is ES855951 to ES876909. Scouts screen along PL Spade. We must hold the Eastern shoulder of the Division Counterattack, which will be launched in thirty minutes. Move to BP 13 (Center of Mass (CoM) ES794907)

as soon as possible (ASAP). Orient SE along Highway 91. Defend to retain BP 13. Do not allow En to penetrate along Highway 91. Alpha Company, you now have Priority of Fires (PoF) and are allocated one Final Protective Fire (FPF) (C/N-BINGO) from ES805903 to ES810906. Report when set.

Event 2: Co Cdr acknowledges, issues movement orders and plt positions, orders move out.

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Non-flagged Radio Traffic

"Y03, this is C06, Moving now, over."

"C06, this is Y03, roger, Out."

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Non-flagged Radio Traffic

"Y03, this is B06, moving now, over."

"B06, this is Y03, roger, out."

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(T+1:45) Event 3: Unit Moves To and Occupies BP 13.

a. Unit moves through CP15, and avoids GEMMS minefield.

b. Unit moves past friendly elements vic BP 42, conducts Identification Friend or Foe (IFF), does not engage friendlies.

(T+2:05) c. Co Cdr reports SET when company has occupied BP 13: Location (SET in BP 13), Activity (Defending, Oriented SE), LOG Status.

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Non-flagged Radio Traffic

"Y03, this is D06, moving now, over."

"D06, this is Y03, roger, out."

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Non-flagged Radio Traffic

"Y03, this is C06, Set. Over."

"C06, this is Y03, roger, out."

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Non-flagged Radio Traffic

"Y03, this is B06, Set, Over."

"B06, this is Y03, roger, out."

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Non-flagged Radio Traffic

"Y03, this is D06, Set, Over."

"D06, this is Y03, roger, out."

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Segment B: Unit Defends BP 13

Event 1: Unit receives Indirect Fire, sends SHELLREP.

//

(T+2:10) Event 2: Unit Assists RPoL of BLUFOR Scouts.

a. Co Cdr receives Intel Update/FRAGO from Bn.
(1) "A06, this is Y03, scouts report two MRBs(+) moving SE to NW toward your position, vic ES834873. B and C Cos report heavy concentrations of indirect fire their locations."
(2) "A06, this is Y03, scouts withdrawing along Highway 91, now designated Passage Lane FROG. Assist their rearward passage of lines.
(a) Co Cdr issues appropriate order to Company.
(b) Co does not engage friendly scouts during their rearward passage of lines.

(T+2:15) Event 3: Unit Defends BP 13 against an MRB (+)

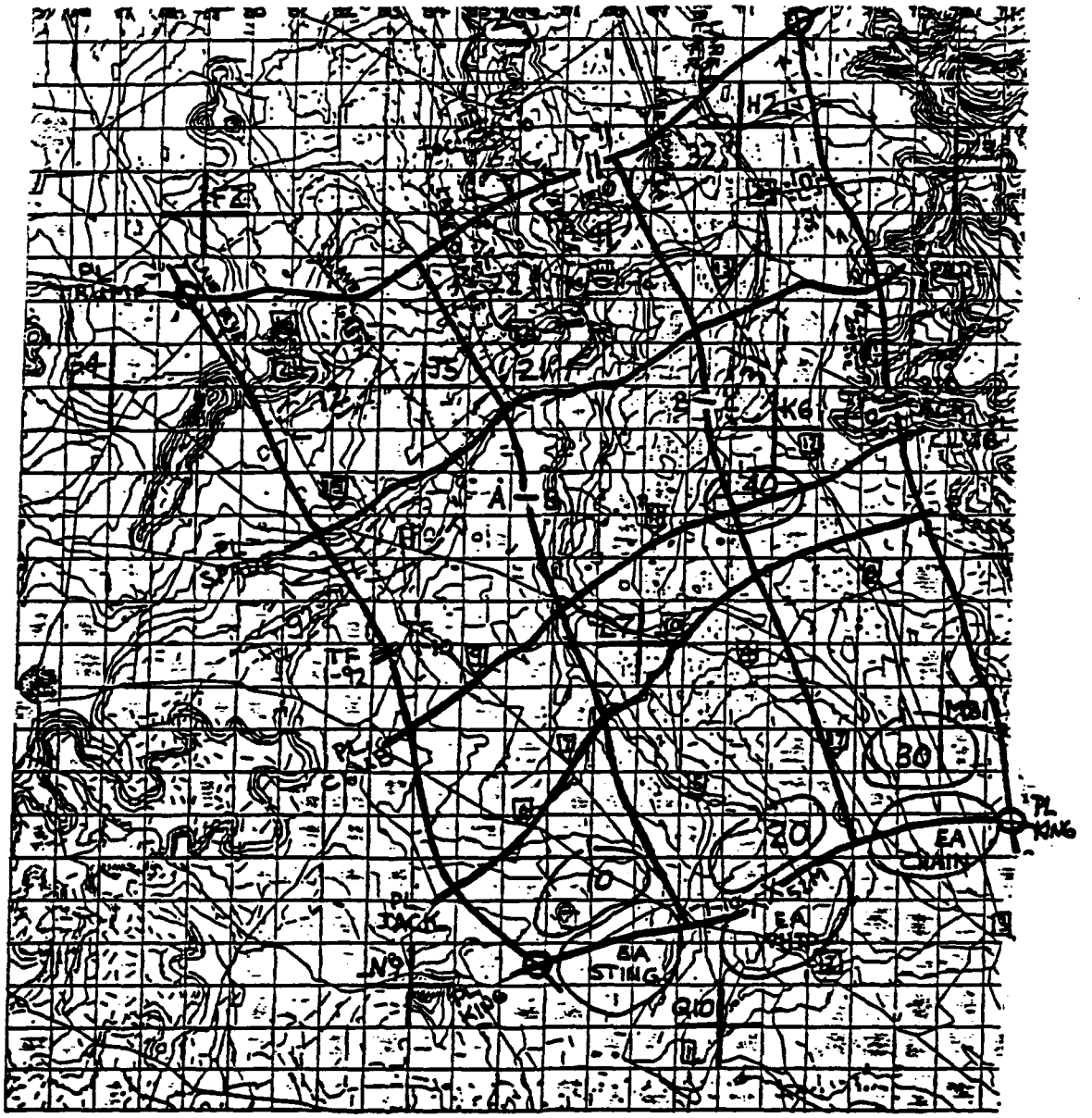
a. Reports
(1) CONTACT - tanks/BMPs, SE (vic ES818884)
(2) SPOTREP - Type (BMPs with tank spt), Location (see above) Number (30-40), Activity (Attacking).

b. Unit engages MRB(+) with Direct and Indirect Fire.
(1) Co Cdr submits CFF.
(2) Co Cdr fires FPF BINGO.
(3) Co Cdr submits SITREP.

c. Unit continues to hold and to report until ENDEX.

(T+2:30) ENDEXxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

---SITUATIONAL AWARENESS ASSESSMENT---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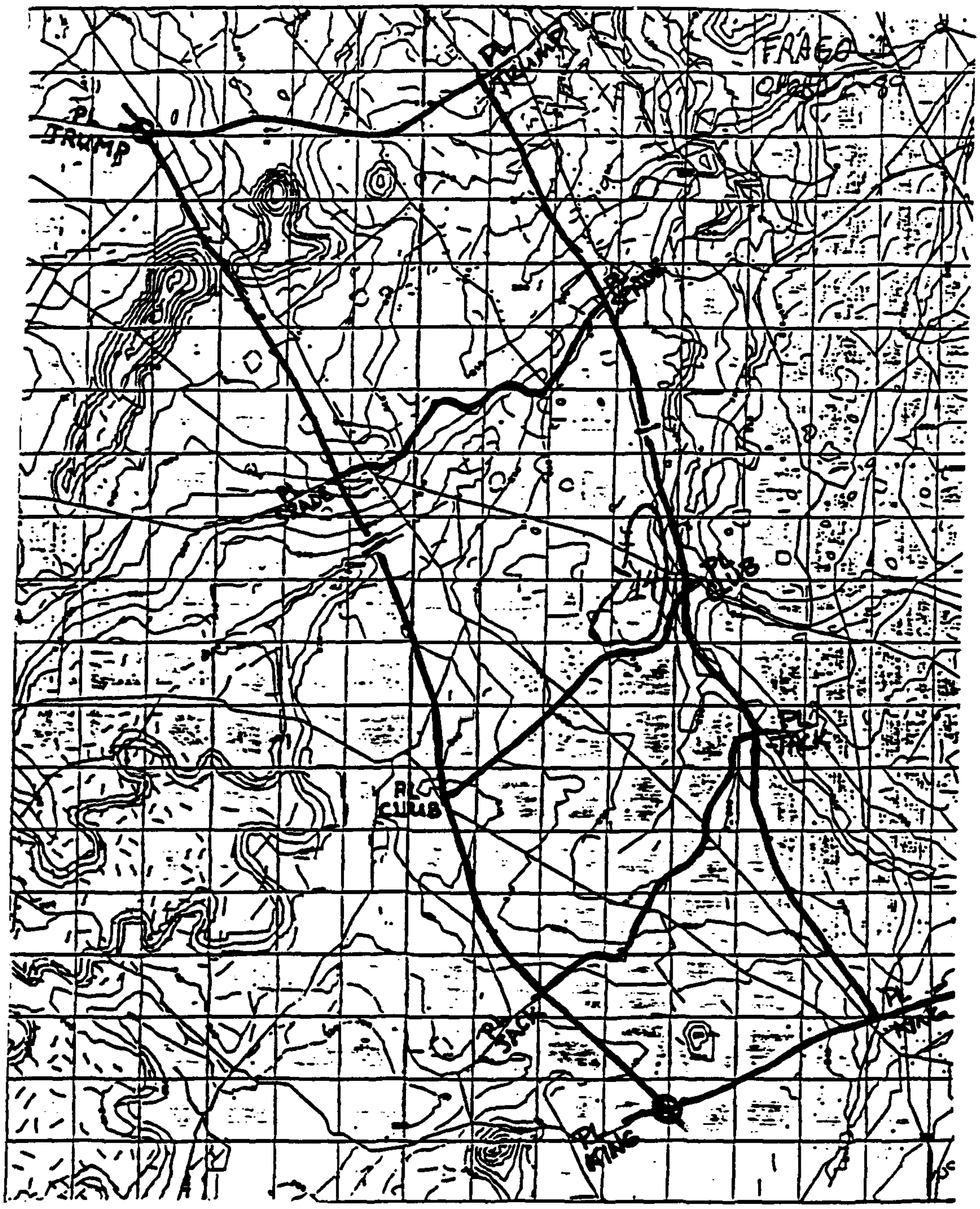
EA
STING
EA
DRAIN
PL
JACK
PL
KING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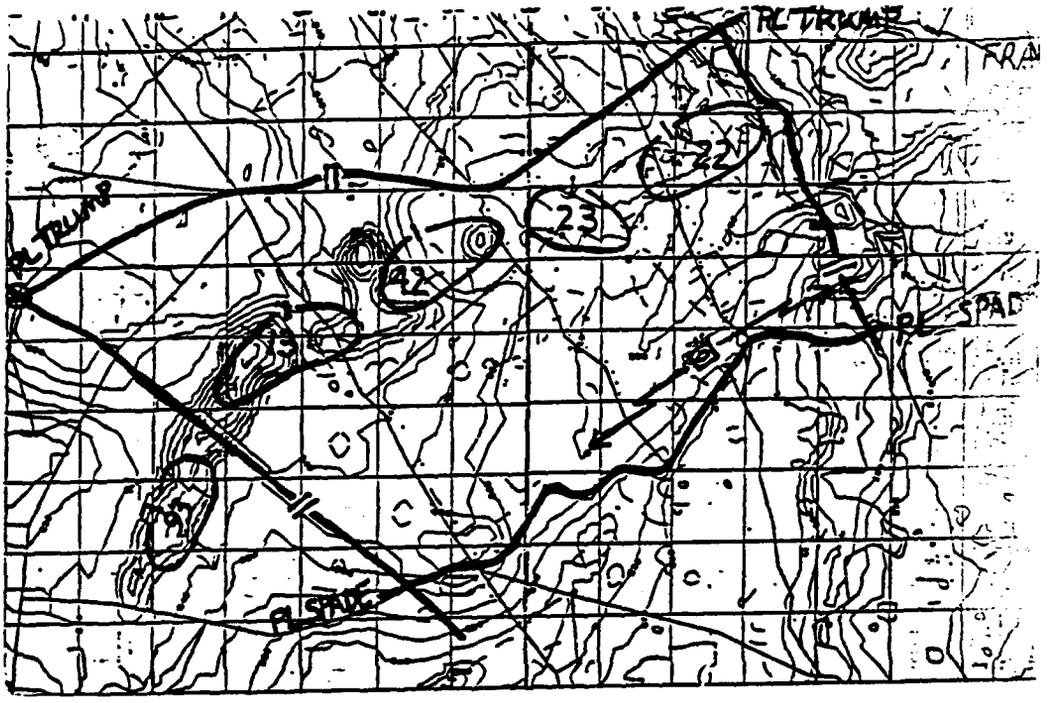
PL TRUMP
FRAGO
PL CLUB
PL JACK
PL JACK
PL KING
PL KING


RL TRUMP
23
42
SPAD
RL SPAD

Appendix A-C

CCD Report Formats

CCD Report Formats

1. CONTACT REPORT
   Purpose: Report Initial Contact With Enemy Forces
   Format:

   LINE #1: WHAT (Tank, PC, Arty, Truck, Helo)
   LINE #2: WHERE (Grid Coordinates)

2. CALL FOR FIRE (CFF) REPORT
   Purpose: Request Indirect Fire
   Format:

   LINE #1: WHAT (Tank, PC, Truck, Arty, Helo)
   LINE #2: WHERE (Grid Coordinates)
   LINE #3: TYPE FIRE (Immediate Suppression, Fire For Effect)

3. ADJUST FIRE REPORT
   Purpose: Adjust Indirect Artillery Or Mortar Fires
   Format:

   LINE #1: ADJUST - LEFT/RIGHT (50, 100, 200, 500 meters)
   LINE #2: ADJUST - ADD/DROP (50, 100, 200, 500 meters)
   LINE #3: TYPE FIRE (Fire for Effect, End of Mission)

4. SPOT REPORT
   Purpose: Report Results of Enemy Contacts, Enemy Activities, And Friendly Activities
   Format:

   PAGE 1: Results of Enemy Contacts
   LINE #1: WHAT (Tank, PC, Truck, Arty, Helo)
   LINE #2: NUMBER DAMAGED
   LINE #3: NUMBER DESTROYED
   LINE #4: WHERE (Grid Coordinates)
   LINE #5: HEADING (Degrees)

   PAGE 2: Enemy/Friendly Activity
   LINE #1: ENEMY ACTIVITY (Moving, Defending, Attacking, Observing)
   LINE #2: FRIENDLY ACTIVITY (Moving, Defending, Attacking, Observing)
   LINE #3: AS OF TIME (Now, -5, -10, -15, -30, -45 Minutes)

5. SHELL REPORT
   Purpose: Report Enemy Indirect Fire Activities and Locations
   Format:

   LINE #1: NUMBER OF SHELLS/ROUNDS
   LINE #2: WHERE (Grid Coordinates)
   LINE #3: AS OF TIME (Now, -5, -10, -15, -30, -45 Minutes)

6. SITUATION REPORT
   Purpose: Report the Commanders/Leaders Location, Enemy Activity, Critical Shortages, and Intent
   Format:

   PAGE 1: Location/Enemy Activity
   LINE #1: AS OF TIME (Now, -5, -10, -15, -30, -45 Minutes)
   LINE #2: FORWARD LINE OF OWN TROOPS (Grid Coordinates, From-To)
   LINE #3: ENEMY ACTIVITY (Light, Medium, Heavy)
   LINE #4: TYPE OF ACTIVITY (Ground Attack, Air Attack, Fire, Defend, Delay, Withdraw)

   PAGE 2: Shortages/Intent
   LINE #5: CRITICAL SHORTAGES (Personnel, Ammo, Equipment, Fuel)
   LINE #6: COMMANDER'S INTENT (No Change, Attack, Recon, Defend, Delay, Withdraw)

7. AMMUNITION REPORT
   Purpose: Report Status of Ammunition for Weapon System
   Format:

   LINE #1: HEAT: STATUS (Green, Amber, Red, Black)
   LINE #2: SABOT: STATUS (Green, Amber, Red, Black)
   LINE #3: .50 cal: STATUS (Green, Amber, Red, Black)
   LINE #4: 7.62mm: STATUS (Green, Amber, Red, Black)
   LINE #5: SMOKE: STATUS (Green, Amber, Red, Black)

8. INTELLIGENCE REPORT
   Purpose: Report Enemy Activities, Friendly Activities, Obstacle Locations
   Format:

   PAGE 1: Enemy Activities
   LINE #1: WHAT (Tank, PC, Truck, Arty, Helo)
   LINE #2: NUMBER (1, 5, 7, 10, 25, etc.)
   LINE #3: ACTIVITY (Ground Attack, Air Attack, Fire, Defend, Delay, Withdraw)
   LINE #4: WHERE (Grid Coordinates)
   LINE #5: HEADING (Degrees)

   PAGE 2: Friendly Activities
   LINE #6: WHAT (Tank, PC, Truck, Arty, Helo)
   LINE #7: NUMBER (1, 5, 7, 10, 25, etc.)
   LINE #8: ACTIVITY (Ground Attack, Air Attack, Fire, Defend, Delay, Withdraw)
   LINE #9: WHERE (Grid Coordinates)
   LINE #10: HEADING (Degrees)

PAGE 3: Obstacles
LINE #11: WHAT (Minefield, Abatis, Wire Obstacle, Blown Bridges)
LINE #12: AS OF TIME (Now, -5, -10, -15, -30, -45)

9. NBC REPORT
Purpose: Report Enemy Nuclear, Biological, and Chemical Operations, Activities, or Attacks
Format:

PAGE 1: Location/Type Burst/Type Attack
LINE #1: OBSERVER LOCATION (Grid Coordinates)
LINE #2: ATTACK LOCATION (Grid Coordinates)
LINE #3: TYPE OF BURST (Air or Surface)
LINE #4: TYPE OF ATTACK (Nuclear, Chemical, Biological)

PAGE 2: Nuclear Attack Information
LINE #5: FLASH/BANG TIME (In Seconds)
LINE #6: NUMBER OF SHELLS/ROUNDS (1, 5, 10, 25, etc.)
LINE #7: NUCLEAR CENTER DIAMETER (In Meters)
LINE #8: NUCLEAR CLOUD WIDTH (In Degrees)
LINE #9: NUCLEAR CLOUD HEIGHT (In Degrees)

Appendix B

Selected Manual Data Collection Instruments

Appendix B contains the following:

B-A	Biographical Questionnaires
B-B	A Representative Situational Awareness Questionnaire
B-C	A Representative Plan View Display (PVD) Log

Appendix B-A

The Biographical Questionnaires

Appendix B-A contains the following:

Wk Sim Dty Pos: PL CC Sim Call # A_____

BIOGRAPHICAL QUESTIONNAIRE - FORM O

Name_____ SSN_____-_____-_____

1. Age _____ years 2. Current Army Rank _____

3. Military Specialty: **12A 12B 12C**

4. Total time in service as enlisted: _____ years/_____ months

5. Total time as commissioned: _____ years/_____ months

6. Total time in Armor (include Cavalry): _____ yrs/_____ months

What Armor vehicles have you been trained on, and how much experience have you had in each (list years/months):

7. **M1** _____ /_____ 10. **M551** _____ /_____

8. **M1A1** _____ /_____ 11.( ) _____ /_____

9. **M60A3** _____ /_____ 12.( ) _____ /_____

13. What is your present tank Duty Position (circle one)?

PL XO CC Other_____

How much experience do you have in each position (years/months)?

14. **TC** _____ / _____ 16. **CoCmdr** _____ / _____

15. **PLdr** _____ / _____ 17. Other _____ / _____

Which of the following formal military courses have you completed? (check all that apply):

18-22. ____ **AIT** ____ **PLDC** ____ **BNCOC** ____ **ANCOC** ____ **AOBC**

23-27. ____ **SPLC** ____ **AOAC** ____ **TCCC** ____ **JMOC** ____ **NBC**

28-31. ____ **CAS3** ____ **RANGER** ____ **AIRBORNE** ____ **OTHER** _____

32. How long has it been since you participated as a tanker in an actual field training exercise (**not counting NTC**):_____ months?

33. How many times have you participated as a tanker in NTC exercises with a rotating unit? _____

34. How many months since your most recent NTC rotation? _____

35. How many hours have you previously spent on SIMNET? _____

36. How many months since the last time you used SIMNET? _____

Wk Sim Dty Pos: PL CC Sim Call # A_____

37. Have you participated in previous new equipment evaluations on SIMNET (in this building)? _____ yes _____ no

If yes, which of the following equipment evaluations have you participated?

38-41. _____ POSNAV _____ IVIS _____ CITV _____Other_____

42. How many hours have you spent on UCOFT? _____

43. How many months since your last UCOFT experience? _____

44. Describe your previous experience with computers (check one):

_____ no experience at all

_____ limited experience

_____ moderate use

_____ considerable experience

45. Education:

_____ High School Diploma/GED

_____ Some College

_____ College Degree (BA/BS)

_____ Postgraduate work

46. What is the source of your commission?

_____ **ROTC** _____ **OCS** _____ **USMA**

47. How much experience have you had in TO&E units?
Please list years/months:

CONUS _____ / _____ **USAREUR** _____ / _____ **KOREA**_____/_____

48. How much experience have you had in TDA units?
Please list years/months:

_____ / _____

PT 5832

A B C 3-28 BIOGRAPHICAL QUESTIONNAIRE FORM-E

Wk Sim Dty Pos: DVR GNR TC PS Sim Call # A_____

BIOGRAPHICAL QUESTIONNAIRE FORM - E

Name_____ SSN_____-_____-_____

1. Age _____ years 2. Current Army Rank _____

3. MOS: **19K** **19E** **Other:** MOS-_____,_____

4. Total time in service as enlisted: _____ years/_____ months

5. Total time in Armor (include Cavalry): _____ yrs/_____ months

What Armor vehicles have you been trained on, and how much experience have you had in each (list years/months):

6. **M1** _____ /_____ 9. **M551** _____ /_____

7. **M1A1** _____ /_____ 10.( ) _____ /_____

8. **M60A3** _____ /_____ 11.( ) _____ /_____

12. What is your present Duty Position: **LDR** **DVR** **GNR** **TC** **PS**

How much experience do you have in each position (years/months)?

13. **LDR** _____ / _____ 15. **GNR** _____ / _____ 17. **PS**____/____

14. **DVR** _____ / _____ 16. **TC** _____ / _____

Which of the following military courses have you completed? (check all that apply):

18-22. ____ **AIT** ____ **PLDC** ____ **BNCOC** ____ **ANCOC** ____ **SPLC**

23-27. ____ **TCCC** ____ **NBC** ____ **Ranger** ____ **Airborne** ____**Other**

28. How long has it been since you participated as a tanker in an actual field training exercise (**not counting NTC**):_____ months?

29. How many times have you participated as a tanker in NTC exercises with a rotating unit? _____

30. How many months since your most recent NTC rotation? _____

31. How many hours have you previously spent on SIMNET? _____

32. How many months since the last time you used SIMNET? _____

33. Have you participated in previous new equipment evaluations on SIMNET (in this building)? ____ yes ____ no

If yes, in which of the following equipment evaluations have you participated?

34-37. _____ POSNAV _____IVIS _____ CITV _____ Other_____

38. How many hours have you spent on UCOFT? _____

39. How many months since your last UCOFT experience? _____

40. Describe your previous experience with computers (check one):

_____ no experience at all

_____ limited experience

_____ moderate experience

_____ considerable experience

41. Education:

_____ High School Diploma/GED

_____ Some College

_____ College Degree (BA/BS)

_____ Postgraduate work

42. How much experience have you had in TO&E units?
Please list years/months:

CONUS_____/_____ **USAREUR**_____/_____ **KOREA**_____/_____

43. How much experience have you had in TDA units?
Please list years/months:

_____/_____

PT 5832

Appendix B-B

A Representative Situational Awareness Questionnaire

WK:_____ SIM DUTY POS:_____ SIM CALL #:_____

RA_____ DATE_____

OFF - TEST

SITUATIONAL AWARENESS/FRAGO #1

You will have five (5) minutes in which to mark/indicate your responses to the following questions on the map sheet provided. The Research Assistant (RA) will time your efforts and will tell you when you are to cease work.

1. Identify your **own vehicle location** with a "cross" or an "X" on the map provided.

2. Using doctrinally correct map symbols, mark the **locations** of **CP 20**, **CP 21**, and **CP 24** on the map provided.

3. On the map provided, mark the **location** of the **enemy minefield**.

PT 5852

Appendix B-C

A Representative Plan View Display (PVD) Log

Wk (CV / _ _ _ _ / _ / _ / _ _) Final

OFFENSIVE - Movement to Contact (MTC)
Company Log

PVD Operator 1:_____ (flagger)

PVD Operator 2:_____ (recorder)

TC ID	Bumper Number (Radio)	Vehicle ID (PVD)
Co Cdr	A06	_____
1st Plt Ldr	A11	_____
2nd Plt Ldr	A21	_____
2nd Plt Ldr Wing	A22	_____
2nd Plt Sgt Wing	A23	_____
2nd Plt Sgt	A24	_____
3rd Plt Sgt	A31	_____

George notified to turn DataLogger ON: _____ ___:___:___
(initials) (time)

DataLogger ON: _____ _____
(time) (flag)

PT 5834

Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

PHASE I: Unit conducts movement to contact to seize OBJ BRONZE.

Segment A: Unit moves to contact. **[Overlay: MTC]**

_____ IA1 **START OF MISSION.** Time_____:_____

_____ IA2b PL2 crosses **LD.** Time_____:_____

_____ IA3a PL1 reports crossing **LD.** Time_____:_____

_____ IA3b PL2 reports crossing **LD.** Time_____:_____

_____ IA3c PL3 reports crossing **LD.** Time_____:_____

IA4 Unit reports 4 destroyed vehicles.

_____ IA4a **SPOTREP** PL1: what_____*loc_____

_____ IA4b **SPOTREP** PL2: what_____ loc_____

_____ IA4c **SPOTREP** PL3: what_____ loc_____

IA5a Radio traffic: "Y02 this is S11, CONTACT, vic ES740890 BMPs moving to cover, out."

IA5b Radio traffic: "Y02, this is S11, SPOTREP, Enemy BMPs, Infantry, location vic ES740890 attacking, I am pinned down, over."

IA5c Radio Traffic: "S11, this is Y03, Indirect fire on the way, HE/VT and Smoke. Attempt to break contact and bypass."

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

*loc = location

Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase I Session A(cont.) - Segment B

IA6a **INTEL UPDATE** - Bn to Co Cdr: "A06, this is Y03, scouts have identified minefield at ES748895 to ES751892 and two BMPs at ES749879. Y02 believes them to be a platoon-sized covering force. Attack to destroy this unit.

_____ IA6b **INTEL UPDATE** - Co Cdr to Plt Ldrs:

_____

Minefield_____

Vehicles_____

Orders_____

Requests for clarification_____ *ETT_____:_____

Segment B: Unit encounters and destroys enemy MR Platoon.

IB1 Enemy engages unit with indirect fire.

_____ IB1a **SHELLREP** PL1: rounds_____ loc_____

_____ IB1b **SHELLREP** PL2: rounds_____ loc_____

_____ IB1c **SHELLREP** PL3: rounds_____ loc_____

_____ _____

_____ _____

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_____ _____

*** ETT** = End of Transmission Time.

Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase I Segment B (cont.)

IB2 Unit receives direct fire from MR Plt vic CP 12 (3 BMPs).

_____ IB2a **CONTACT** Report PL1: what_____ dir_____

_____ IB2b **CONTACT** Report PL2: what_____ dir_____

_____ IB2c **CONTACT** Report PL3: what_____ dir_____

_____ IB3a **CFF** PL1: what_____ loc_____

_____ IB3b **CFF** PL2: what_____ loc_____

_____ IB3c **CFF** PL3: what_____ loc_____

_____ IB4a **SPOTREP** PL1: what_____ loc_____

_____ IB4b **SPOTREP** PL2: what_____ loc_____

_____ IB4c **SPOTREP** PL3: what_____ loc_____

IB5 Unit observes Scout vehicles vic Minefield.

_____ IB5a **SPOTREP** PL1: what_____ loc_____

_____ IB5b **SPOTREP** PL2: what_____ loc_____

_____ IB5c **SPOTREP** PL3: what_____ loc_____

_____ IB6b PLT 2 enters the **Minefield.** Y N Time_____:_____

_____ _____

_____ _____

_____ _____

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_____ _____

_____ _____

Phase I Segment B (cont.)

_____ IB7b PL2 crosses **PL JIM.** Time_____:_____

_____ IB8a PL1 reports crossing **PL JIM.** Time_____:_____

_____ IB8b PL2 reports crossing **PL JIM.** Time_____:_____

_____ IB8c PL3 reports crossing **PL JIM.** Time_____:_____

IB9 Unit receives indirect fire.

_____ IB9a **SHELLREP** PL1: rounds_____ loc_____

_____ IB9b **SHELLREP** PL2: rounds_____ loc_____

_____ IB9c **SHELLREP** PL3: rounds_____ loc_____

IB10 Unit fights to seize OBJ BRONZE: 3 tanks at ES775842; MR Plt (3 BMPs) at ES762828; then destroys Enemy Trains/ 2 fuel, 2 ammo trucks, 1 rec vehicle, 1 tank.

_____ IB10a **CONTACT** Report PL1: what_____ dir_____

_____ IB10b **CONTACT** Report PL2: what_____ dir_____

_____ IB10c **CONTACT** Report PL3: what_____ dir_____

_____ IB11a **CFF** PL1: what_____ loc_____

_____ IB11b **CFF** PL2: what_____ loc_____

_____ IB11c **CFF** PL3: what_____ loc_____

_____ IB12a **SPOTREP** PL1: what_____ loc_____

_____ IB12b **SPOTREP** PL2: what_____ loc_____

_____ IB12c **SPOTREP** PL3: what_____ loc_____

_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase I Segment B (cont.)

_____ IB13a PL1 reports **OBJ BRONZE.** Time_____:_____

_____ IB13b PL2 reports **OBJ BRONZE.** Time_____:_____

_____ IB13c PL3 reports **OBJ BRONZE.** Time_____:_____

Segment C: Consolidation and reorganization on OBJ BRONZE.

IC1 Situation Reports: Unit consolidates and reorganizes on OBJ BRONZE, vic CP 15.

_____ IC1a **SITREP** PL1: loc_____ activity_____

***ncs**___ pers_____ ammo_____ fuel_____ equip_____

_____ IC1b **SITREP** PL2: loc_____ activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____ IC1c **SITREP** PL3: loc_____ activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____ _____

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***ncs**=no critical shortages

Phase I Segment C (cont.)

IC2a **NBC** Incident - The Semiautomated Forces (SAFOR) operator drops two volleys of artillery vic ES8280, then calls A11 on 1st platoon frequency with the following report: "A11, this is A14, SHELLREP. Observed ten rounds arty at ES8280."

_____ IC2b **SHELLREP** PL1: rounds_____ loc_____

IC2d NBC Incident continued: "A11, this is A14, follow-up to SHELLREP, observing a gaseous mist vic of arty impacts at ES8280."

_____ IC2e **NBC Report** PL1: loc_____ # shells___

type of burst_____ type of attack_____

IC2f NBC Incident continued: "A11, this is A13, have identified gas as 'Vx' Nerve Agent, using M8 paper and M256."

_____ IC2g **NBC Report** PL1: loc_____ # shells___

type of burst_____ type of attack_____

_____ IC3a **BREAK.** Time_____:_____

_____ IC3b End of **BREAK**: Troops return to simulators (SIMs.)
Time_____:_____

_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

PHASE II: Unit receives FRAGO to move to seize OBJ SILVER.

Segment A: Unit receives FRAGO #1. **[Overlay: MTCFRAG1]**

IIA1a **FRAGO #1** sent from Bn to CC: Para 1 - "TF 1-91 has been held on our Eastern Flank near PL JIM. An enemy Tank Co (+) is withdrawing to the Southeast." Para 2 - "Move to Contact to OBJ SILVER to destroy withdrawing enemy unit."
Para 3a - Area of OPS - Boundaries:
Northeast RJ ES946804 Southeast RJ ES929742 Northwest RJ ES830831 Southwest RJ ES802781
West Boundary: PL PAULA East Boundary: PL MIKE PL PAM: Road ES878821 - ES843769
CP 20 RJ ES847790 CP 21 hill ES874788 CP 24 RJ ES8978 Ctr Mass SILVER ES895790
Para 3b - "Alpha Company leads Battalion diamond as advanced guard. Tm B follows on Southern flank, Tm C in the North and D Co trailing. Alpha Company crosses LD at (T+1:15) and moves through CP 20 and CP 21 to seize CP 24."

_____ IIA1b **FRAGO #1** sent from Co Cdrs to Plt Ldrs:

_____

Boundaries NE_____ NW_____

SE_____ SW_____

PL PAULA_____ PL MIKE_____

PL PAM_____

CP 20_____ CP 21_____

CP 24_____ CM SILVER_____

Orders_____

_____

Requests for clarification _____ ETT_____:_____

_____ IIA2b PL2 crosses **PL PAULA.** Time_____:_____

_____ IIA3a PL1 reports crossing **PL PAULA.** Time_____:_____

_____ IIA3b PL2 reports crossing **PL PAULA.** Time_____:_____

_____ IIA3c PL3 reports crossing **PL PAULA.** Time_____:_____

_____ _____

_____ _____

_____ _____

_____ _____

Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase II (cont.)

Segment B: Unit encounters enemy en route to OBJ SILVER.

IIB1 Unit receives indirect fire from MR Plt at Hill 250 vic ES874788.

_____IIB1a **SHELLREP** PL1: rounds_____ loc_____

_____IIB1b **SHELLREP** PL2: rounds_____ loc_____

_____IIB1c **SHELLREP** PL3: rounds_____ loc_____

IIB2a **INTEL UPDATE** sent from Bn to Co Cdr: "A06, this is Y03, scouts report Minefield vic ES876788 to ES879791. Also report 2 BMPs vic ES874787."

_____IIB2b **INTEL UPDATE** from Co Cdr to Plt Ldrs:

_____

Minefield_____

Vehicles_____

 # Requests for clarification _____ ___ ETT_____:_____

_____IIB3b PL2 crosses **PL PAM.** Time_____:_____

_____IIB4a PL1 reports crossing **PL PAM.** Time_____:_____

_____IIB4b PL2 reports crossing **PL PAM.** Time_____:_____

_____IIB4c PL3 reports crossing **PL PAM.** Time_____:_____

_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase II Segment B (cont.)

IIB5 Unit engages 3 BMPs, 6 howitzers vic ES874787.

_____IIB5a **CONTACT** Report PL1: what_____ dir____

_____IIB5b **CONTACT** Report PL2: what_____ dir____

_____IIB5c **CONTACT** Report PL3: what_____ dir____

_____IIB6a **CFF** PL1: what_____ loc_____

_____IIB6b **CFF** PL2: what_____ loc_____

_____IIB6c **CFF** PL3: what_____ loc_____

_____IIB7a **SPOTREP** PL1: what_____ loc_____

_____IIB7b **SPOTREP** PL2: what_____ loc_____

_____IIB7c **SPOTREP** PL3: what_____ loc_____

IIB8a **Intelligence Summary (INTSUM):** "A06, this is Y03, enemy tank company has passed the OBJ and is now vic. ES9972. 1-10 ARMOR will consolidate on OBJ SILVER. New orders follow. Be prepared to move within 10 min. of receipt of orders. Send SITREP. Acknowledge, over."

_____ IIB8b **INTSUM** from Co Cdr to Plt Ldrs:

_____

_____

_____

Requests for clarification_____ ETT_____:_____

_____ _____

_____ _____

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_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase II Segment B

_____ IIB9a **SITREP** PL1: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____ IIB9b **SITREP** PL2: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____ IIB9c **SITREP** PL3: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

Segment C: Consolidation and reorganization on OBJ SILVER.

IIC1 Unit reports 2 destroyed trucks, 1 recovery vehicle.

_____IIC1a **SPOTREP** PL1: what_____ loc_____

_____IIC1b **SPOTREP** PL2: what_____ loc_____

_____IIC1c **SPOTREP** PL3: what_____ loc_____

_____IIC2a **BREAK** for Situational Awareness. Time_____:_____

_____IIC2b END of **BREAK**; troops return to SIMs. Time_____:_____

_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase III: Unit receives FRAGO #2 to seize OBJ GOLD.

Segment A: Unit receives FRAGO #2. **[Overlay: MTCFRAG2]**

IIIA1a **FRAGO #2** sent from Bn to CC: Para 1 - "TF 1-91 has eliminated resistance at PL JIM and is ready to continue movement." Para 2 - "1-10 Armor conducts movement to Contact to OBJ GOLD to maintain pressure on withdrawing enemy." Para 3a - Area of Operations - Boundaries: Northeast RJ ES914782 Northwest Hill ES875788 Southwest RJ ES842702 Southeast RJ ES912690 North Boundary LD/PL TAMMY ES875788-ES914782 South Boundary Limit of Advance (LOA)/PL LISA ES842702-ES912690 CP31 Rd bend ES888753 CP32 Hill ES866732 CP33 Hill ES883699 Ctr Mass GOLD ES880620 PL FORD ES911726 - ES852735 Para 3b - "Alpha Company leads Battalion diamond as advanced guard. Team B follows on the West flank, Team C to the East and D Co trailing. Alpha Company crosses LD at (T+2:15) moving West of CP 31 & through CP 32 to sieze OBJ GOLD."

_____ IIIA1b **FRAGO #2** sent from Co Cdr to Plt Ldrs:

_____

_____

_____

Boundaries: NE_____ NW_____

SE_____ SW_____

LD/PL TAMMY_____

LOA/PL LISA_____

CP31_____ CP32_____

CP33_____ CoM GOLD_____

PL FORD_____

_____

_____

_____

Requests for clarification _____ ETT_____:_____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase III Segment A (cont.)

_____IIIA2b PL2 crosses **PL TAMMY.** Time_____:_____

_____IIIA3a PL1 reports crossing **PL TAMMY.** Time_____:_____

_____IIIA3b PL2 reports crossing **PL TAMMY.** Time_____:_____

_____IIIA3c PL3 reports crossing **PL TAMMY.** Time_____:_____

IIIA4 Unit encounters dead vehicles.

_____IIIA4a **SPOTREP** PL1: what_____ loc_____

_____IIIA4b **SPOTREP** PL2: what_____ loc_____

_____IIIA4c **SPOTREP** PL3: what_____ loc_____

_____IIIA5b PL2 crosses **PL FORD.** Time_____:_____

_____IIIA6a PL1 reports crossing **PL FORD.** Time_____:_____

_____IIIA6b PL2 reports crossing **PL FORD.** Time_____:_____

_____IIIA6c PL3 reports crossing **PL FORD.** Time_____:_____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase III (cont.)

Segment B: Unit moves to; fights for OBJ GOLD.

IIIB1 Enemy engages unit with indirect fire:

_____IIIB1a **SHELLREP** PL1: round_____ loc_____

_____IIIB1b **SHELLREP** PL2: round_____ loc_____

_____IIIB1c **SHELLREP** PL3: round_____ loc_____

IIIB2 Unit receives direct fire from 3 tanks.

_____IIIB2a **CONTACT** Report PL1: what_____ dir____

_____IIIB2b **CONTACT** Report PL2: what_____ dir____

_____IIIB2c **CONTACT** Report PL3: what_____ dir____

_____IIIB3a **CFF** PL1: what_____ loc_____

_____IIIB3b **CFF** PL2: what_____ loc_____

_____IIIB3c **CFF** PL3: what_____ loc_____

_____IIIB4a **SPOTREP** PL1: what_____ loc_____

_____IIIB4b **SPOTREP** PL2: what_____ loc_____

_____IIIB4c **SPOTREP** PL3: what_____ loc_____

_____ _____

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Flag 3-16 OFFENSIVE MOVEMENT TO CONTACT SCENARIO - COMPANY LOG

Phase III Segment B (cont.) - Segment C

IIIB5a **INTEL UPDATE** from Bn to Co Cdr: "A06, this is Y03, an Enemy counterattack of Tank Battalion size (+) is reported heading North towards OBJ GOLD. Maintain hasty defense at OBJ GOLD and defeat this counterattack."

_____IIIB5b **INTEL UPDATE** from Co Cdr to Plt Ldrs:

_____

_____

_____

Requests for clarification _____ ETT_____:_____

IIIB6 Unit Consolidates and Reorganizes on OBJ GOLD.

_____IIIB6a **SITREP** PL1: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____IIIB6b **SITREP** PL2: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

_____IIIB6c **SITREP** PL3: loc_____activity_____

ncs___ pers_____ ammo_____ fuel_____ equip_____

Segment C: Unit engages in last battle; fights for OBJ GOLD.

_____IIIC3 **END OF EXERCISE** declared by Commander; **BREAK** for Situational Awareness exercise. Time_____:_____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

NOTIFY GEORGE TO TURN OFF DATALOGGER _____ **TIME**_____:_____

PT 5834

Appendix C

Measures and Their Scoring Rules

LIST OF MEASURES WITH DEFINITIONS

CVCC COMPANY LEVEL EVALUATION

I. Mission performance

1. Number of phases completed

<<<< Of 3 phases (missions) scripted, the number completed in each scenario. One measure per company per scenario. >>>>

2. Time to complete phase

<<<< Elapsed time (in minutes) from start of mission execution (following REDCON 1) to completion of last scripted event in the phase; excludes planning and in-sim preparation preceding Phase I. One measure per company per phase. >>>>

3. Percent of enemy vehicles killed by BLUFOR

<<<< Of the total number of enemy vehicles participating in the battle, the proportion killed by entire friendly force (manned and semiautomated vehicles); excludes "mobility kills." One measure per phase. >>>>

4. Percent of enemy losses scored by manned vehicles

<<<< Of the total number of enemy vehicles killed by BLUFOR direct fire, the share accounted for by the seven manned sims combined. One measure per company per phase. >>>>

5. Number of manned vehicle losses

<<<< Cumulative number of times each manned vehicle sustained hits which the computer classified as destroyed (notional kills); includes fratricide kills; may occur repeatedly for each vehicle. One measure per vehicle per phase. >>>>

6. Number of tethered vehicle losses

<<<< Cumulative number of times the combined tethered vehicles sustained direct-fire hits which the computer classified as "destroyed;" includes fratricide kills; excludes "mobility kills." One measure per company per phase. >>>>

7. Number of losses per kill (ratio), manned vehicles

<<<< Total number of enemy kills by manned vehicles compared to total number of kills inflicted on manned vehicles by enemy force. One measure per company per phase. >>>>

8. Time to loss of mission effectiveness

<<<< Elapsed time (in minutes) from start of mission execution to loss of six vehicles (both manned and tethered, including fratricide kills) in the manned BLUFOR company; marks the point beyond which mission could not have been effectively accomplished. One measure per company per phase. >>>>

II. Information acquisition and communication

1. Number of named reports originated

<<<< Volume of formatted reports created and then transmitted by CCD (CVCC only) and by voice radio (CVCC and M1 Baseline), sorted by report type as defined by accepted armor practice. Formatted reports included: Contact, Spot, Call for Fire, Adjust Fire, NBC, Situation, Shell, Ammunition Status, and Route. One set of measures per Co Cdr/Plt Ldr per phase. >>>>

2. Number of "other" radio messages sent

<<<< Volume of unformatted messages (addressing movement, location, etc. of friendly and enemy vehicles) transmitted by voice radio; excludes formatted reports and repeats, readiness condition reports, clarifications, and administrative messages. One measure per Co Cdr/Plt Ldr per phase. >>>>

3. Number of requests to clarify FRAGOs and INTEL reports

<<<< Total number of times the Co Cdr and Plt Ldrs requested clarification of FRAGOs (Phases II and III only) and INTEL reports (all phases); summed across the Co Cdr and three Plt Ldrs. One measure per company per phase. >>>>

4. Accuracy of first CONTACT report [see Tactical Assessment and Planning category, measure #3]

5. Accuracy of SHELL reports [see Tactical Assessment and Planning category, measure #6]

6. Accuracy of CALL FOR FIRE reports [see Tactical Assessment and Planning category, measure #7]

7. Percent of named reports transmitted by voice radio

<<<< Proportion of formatted reports which the CVCC Co Cdr and Plt Ldrs transmitted by voice radio (vs. CCD); computed by report type; applies to CVCC Co Cdr and Plt Ldrs only. One set of measures per CVCC Co Cdr/Plt Ldr per phase. >>>>

8. Percent of reports retrieved (overall)

<<<< Cumulative proportion of reports received on the CCD whose contents were "opened" by the vehicle commander; summed across all report types except routes; applies to CVCC vehicle commanders only. One measure per CVCC vehicle commander per phase. >>>>

9. Percent of reports retrieved, by type

<<<< Proportion of reports received on the CCD whose contents were "opened" by the vehicle commander, computed by report type; applies to CVCC vehicle commanders only. One set of measures per CVCC vehicle commander per phase. >>>>

10. Percent of reports relayed, by type

<<<< Proportion of reports received on the CCD which were subsequently transmitted upward or downward; computed by report type; applies to CVCC Co Cdr and Plt Ldrs only. One set of measures per CVCC Co Cdr/Plt Ldr per phase. >>>>

11. Median time to retrieve reports, by type

<<<< Elapsed time (in minutes) from receiving a report on the CCD to first "opening" of that report by the vehicle commander; computed by report type; applies to CVCC vehicle commanders only. One set of measures per CVCC vehicle commander per phase. >>>>

12. Median time to relay reports, by type

<<<< Elapsed time (in minutes) from receiving a report on the CCD to first relay of the same report upward or downward; computed by report type; applies to CVCC Co Cdr and Plt Ldrs only. One set of measures per CVCC Co Cdr/Plt Ldr per phase. >>>>

13. Median time to relay reports full-net

<<<< Elapsed time (in minutes) from CCD transmission of report on Bn or 2d Plt net to transmission of the same report on the most distant net; computed by transmission direction (up or down); applies to CVCC companies only. One set of measures per CVCC company per phase. >>>>

14. Percent time vehicle commander used vision blocks, GPSE, CITV, CCD map

<<<< Relative proportion of time the vehicle commander used each available means (VBs, GPSE, CITV, and CCD tactical map) to obtain information about the battlefield environment "outside" the sim; judged by RA/observers; applies to CVCC vehicle commanders only. One set of measures per CVCC vehicle commander per scenario. >>>>

III. Tactical assessment & planning

1. Time taken by Co Cdr to process FRAGO

<<<< Elapsed time (in minutes) from start of transmission of FRAGO by Battalion staff to start of subsequent transmission of FRAGO by Co Cdr, reflecting Co Cdr's planning and processing; based on voice radio portion of FRAGO in CVCC condition; applies only to Phases II and III of scenario. One measure per Co Cdr per phase. >>>>

2. Index for Co Cdr's FRAGO

<<<< Tactical effectiveness of the Co Cdr's FRAGO as transmitted to Plt Ldrs, reflecting both timeliness (speed of starting the mission) and accuracy (correct inclusion of essential elements - what, when, where, why, how); in CVCC condition, content is both oral (voice radio) and electronic (CCD; fixed); applies only to Phases II and III of scenario; determined by criterion scoring. One measure per Co Cdr per phase. >>>>

3. Accuracy of first CONTACT report

<<<< Accuracy of first reported sighting of enemy vehicles (first transmission of CONTACT report on company or battalion radio net); based on reported "what" (tanks, personnel carriers, trucks, artillery, helicopters) and "where" (proximity to actual location of enemy vehicle, not to exceed 500 m radius); determined by criterion scoring. One measure per company per phase. >>>>

4. Timeliness of first CONTACT report

<<<< Timeliness of unit's reporting of first contact with enemy; based on elapsed time (in minutes) from first reported sighting of enemy (first transmission of CONTACT report) by Plt Ldr or Co Cdr to start of engagement (first friendly or enemy shot fired); determined by criterion scoring. One measure per company per phase. >>>>

5. Combined index for first CONTACT report

<<<< Index of tactical usefulness of first reported sighting of enemy (first transmitted CONTACT report) by Plt Ldr or Co Cdr, integrating both accuracy and timeliness (see III-1.A and III-2.A); determined by criterion scoring. One measure per company per phase. >>>>

6. Accuracy of SHELL reports

<<<< Accuracy of SHELL reports transmitted by a Plt Ldr or the Co Cdr following start of artillery shelling; based on reported "where" (proximity to actual location of impact points, not to exceed 500 m radius), determined by criterion scoring. One set of measures per company per phase. >>>>

7. Accuracy of CALL FOR FIRE (CFF) reports

<<<< Accuracy of CFFs transmitted by Co Cdr on battalion net; based on reported "what" (enemy tank, personnel carrier, truck, artillery, helicopter) and "where" (proximity to actual location of enemy target, not to exceed 500 m radius); determined by criterion scoring. One set of measures per company per phase. >>>>

8. SPOT report index

<<<< Effectiveness of each platoon's reporting of enemy vehicles killed, as indicated by SPOT reports transmitted by each Plt Ldr; based on aggregate number of enemy vehicles reported killed by each platoon and on types of enemy vehicles reported killed; determined by criterion scoring. One measure per platoon per phase. >>>>

9. Unit Displacement range (defense only)

<<<< Direct distance (in meters) between the closest friendly (manned) and enemy vehicle at the time the Co Cdr orders the first element to displace; applies to Phase I of defensive/delay scenario only. One measure per company per defensive scenario. >>>>

10. Map plot index

<<<< Accuracy of the vehicle commander's recall of the battlefield situation; assessed by asking the vehicle commander to plot selected tactical positions on an unmarked paper map of the battlefield; based on scoring the distance between the plotted and correct locations; applies only to Phases II and III. One measure per vehicle commander per phase. >>>>

11. Paper map overlay usage index

<<<< Effectiveness in maintaining the overlay to the paper map; reflects mainly accuracy (relative error in plotting tactical features); applies only to scenario phases where a FRAGO prompted updating of the map overlay (Phases II and III). One measure per vehicle commander per phase. >>>>

IV. Operational control of unit

1. Percent of rounds fired by Co Cdr & Plt Ldrs

<<<< Of the total main gun rounds (HEAT + sabot) expended by all manned sims, the proportion which was fired by each Co Cdr/Plt Ldr's sim; inversely related to amount of time the vehicle commander spends on command and control activities. One measure per Co Cdr/Plt Ldr crew per phase. >>>>

2. Co Cdr distance from company center of mass (offense only)

<<<< Distance (in meters) of the Co Cdr's vehicle from the company's geometric center of mass (CoM), defined relative to the 2d platoon CoM and the 1st and 3d Plt Ldr's locations; computed every 30 sec; applies to offensive scenario only. One set of measures per Co Cdr per phase. >>>>

3. Percent of time company dispersion >600 m (offense only)

<<<< Proportion of time dispersion of the company's manned sims exceeded the acceptable maximum (defined by Army doctrine); company dispersion is defined as linear distance (in meters) between the company's geometric CoM (see IV-3) and the unit's manned vehicle most distant from the CoM; based on 30-sec sampling cycle; applies to offensive scenario only. One measure per company per phase. >>>>

4. Percent of time 2d plt dispersion >200 m (offense only)

<<<< Proportion of time dispersion of 2d platoon's vehicles exceeded the acceptable maximum (defined by Army doctrine); platoon dispersion is defined as linear distance (in meters) between the platoon's geometric CoM (defined relative to the locations of all four of the unit's vehicles) and the unit's vehicle most distant from the CoM; based on 30-sec sampling cycle; applies to offensive scenario only. One measure per company per phase. >>>>

5. Percent of time company dispersion <300 m (offense only)

<<<< Proportion of time dispersion (see IV-4) of the company's manned sims fell below the acceptable minimum (defined by Army doctrine); based on 30-sec sampling cycle; applies to offensive scenario only. One measure per company per phase. >>>>

6. Percent of time 2d plt dispersion <100 m (offense only)

<<<< Proportion of time dispersion (see IV-5) of 2d platoon's vehicles fell below the acceptable minimum (defined by Army doctrine); based on 30-sec sampling cycle; applies to offensive scenario only. One measure per company per phase. >>>>

7. Number of fratricide hits

<<<< Cumulative number of hits by manned sims against friendly vehicles (manned and semiautomated). One measure per crew per phase. >>>>

8. Number of fratricide kills

<<<< Cumulative number of kills by manned sims against friendly vehicles (manned and semiautomated). One measure per crew per phase. >>>>

V. Unit positioning & navigation

1. Distance travelled

<<<< Cumulative distance (in meters) driven while executing the mission; based on vehicle odometer reading. One measure per vehicle per phase. >>>>

2. Fuel used

<<<< Total amount of fuel (in gallons) consumed in executing the mission. One measure per vehicle per phase. >>>>

3. Mean velocity (while moving)

<<<< Mean vehicle velocity (in km/hr) while executing the mission; based on 30-sec sampling cycle; excludes periods at halt. One measure per vehicle per phase. >>>>

4. Percent of time MOVING velocity >40 km/hr

<<<< Proportion of time during mission execution when vehicle velocity exceeded 40 km/hr; based on 30-sec sampling cycle; excludes periods at halt. One measure per vehicle per phase. >>>>

5. Percent of time at halt (offense only)

<<<< Proportion of time vehicle velocity was zero during mission execution; based on 30-sec sampling cycle; applies to offensive scenario only. One measure per vehicle per phase. >>>>

6. Number of times out of sector

<<<< Number of times a manned vehicle travelled identifiably outside established boundaries of the unit's assigned sector; judged by PVD operator relative to overlay graphics on PVD screen. One measure per crew per phase. >>>>

VI. Target acquisition & engagement

1. Maximum lasing range

<<<< Distance (in meters) from own vehicle to potential target, determined by use of laser; includes LRF use by vehicle commander and gunner (CVCC and M1 Baseline) and CITV laser locator use by vehicle commander (CVCC only); excludes indeterminate readings. One measure per crew per phase. >>>>

2. Median target hit range

<<<< Distance (in meters) from a firing manned vehicle to the enemy vehicle hit by the round fired; hits classified by the computer. One measure per crew per phase. >>>>

3. Percent of targets hit >2200 m

<<<< Of the total number of enemy vehicle hits scored by manned vehicle firings, the proportion occurring at distances greater than 2200 m. One measure per crew per phase. >>>>

4. Median target kill range

<<<< Distance (in meters) from a firing manned vehicle to the enemy vehicle killed by the round fired; kills classified by the computer. One measure per crew per phase. >>>>

5. Percent of targets killed >2200 m

<<<< Of the total number of enemy vehicles killed by manned vehicle firings, the proportion killed at distances greater than 2200 m. One measure per crew per phase. >>>>

6. Percent of enemy vehicles killed by BLUFOR
[see Mission Performance category, measure #3]

7. Percent of enemy losses scored by manned vehicles
[see Mission Performance category, measure #4]

8. Number of targets hit using Designate

<<<< Number of enemy vehicle hits each manned vehicle scored immediately following the vehicle commander's designation of a target; based on firings within 15 sec of the designate event; applies to CVCC vehicles only. One measure per CVCC crew per phase. >>>>

9. Number of targets hit using Target Stack

<<<< Number of enemy vehicle hits each manned vehicle scored immediately following the gunner's selection of a target from the Target Stack; based on firings within 30 sec of the target selection; applies to CVCC vehicles only. One measure per CVCC crew per phase. >>>>

10. Number of hits taken by manned vehicles

<<<< Cumulative number of direct fire hits sustained by each manned vehicle; excludes fratricide hits. One measure per vehicle per phase. >>>>

11. Number of manned vehicle losses [see Mission Performance category, measure #5]

VII. CCD usage

1. Percent of time each map scale active

<<<< Proportion of time during mission execution each map scale (1:25K, 1:50K, 1:125K, 1:250K) was in effect on the vehicle commander's tactical map; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

2. Percent of time each map scroll function active

<<<< Proportion of time during mission execution each map scroll function (enabled, locked, centered, off-centered, move) was in effect for each vehicle commander's tactical map; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

3. Percent of time each map feature active

<<<< Proportion of time during mission execution each map feature (grid, contours, rivers, roads, vegetation) was "on" each vehicle commander's tactical map; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

4. Percent of control inputs accomplished by touchscreen

<<<< Proportion of the total number of control inputs to the CCD effected by touchscreen (vs. thumb control); available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

5. Percent of grid inputs to reports by lasing

<<<< Proportion of the total number of grid location inputs to CCD reports effected by laser device (vs. CCD tactical map); available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

6. Number of CCD reports originated per hour

<<<< Frequency of CCD messages created and then transmitted by each vehicle commander, collapsed across all report types; excludes repeats and relays; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

7. Percent of prepared reports transmitted

<<<< Proportion of reports prepared on the CCD which were transmitted (vs. cancelled) by the vehicle commander; computed by report type; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

8. Percent of received rpts retrieved, by queue/file/icon

<<<< Proportion of reports received on the CCD which were "opened" by the vehicle commander, computed by source (queue, file, icon); available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

9. Number of retrievals per report

<<<< Number of times each report received on the CCD was "opened" by the vehicle commander; computed by report type; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

10. Median number of icons on tactical map

<<<< Median number of icons (symbols representing vehicles, reports, waypoints, etc.) appearing on the vehicle commander's tactical map at any given time; based on 30-sec sampling cycle; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase.
[Note: Icons represent both reports in the "receive" queue and reports "posted" by the vehicle commander.] >>>>

11. Median number of icons posted to tactical map

<<<< Median number of icons representing reports "posted" by the vehicle commander to his tactical map at any given time; based on 30-sec sampling cycle; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

VIII. CITV usage

1. Percent of time in each operating mode

<<<< Proportion of time during mission execution each CITV mode (off, cooling, standby, GPS, gun line of sight, manual search, autoscan) was in effect; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

2. Percent of time in BHOT/WHOT

<<<< Proportion of time during mission execution each polarity state (Black-hot, White-hot) was in effect; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

3. Percent of time in 3X/10X

<<<< Proportion of time during mission execution each magnification power (3X, 10X) was in effect; based on 30-sec sampling cycle; available for CVCC vehicles only. One set of measures per CVCC vehicle commander per phase. >>>>

4. Number of times autoscan sector set per hour

<<<< Frequency with which the vehicle commander repositioned the left and/or right markers defining the limits of the CITV's autoscan sector; adjustments separated by 45 sec or less were counted as a single reset; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

5. Mean autoscan sector width (degrees)

<<<< Width (in degrees) of the autoscan sector defined by the left and right markers; based on 30-sec sampling cycle; applies to CVCC vehicles only. One measure per vehicle commander per phase. >>>>

6. Number of times autoscan rate set per hour

<<<< Frequency with which the vehicle commander set/reset (increased or decreased) the autoscan sweep rate; adjustments separated by 30 sec or less were counted as a single reset; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

7. Mean autoscan rate

<<<< Autoscan sweep rate (in degrees per sec) set by the vehicle commander; based on 30-sec sampling cycle; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

8. Number of times vehicle commander entered targets in Target Stack

<<<< Cumulative number of times the vehicle commander entered targets in any of the four positions in the Target Stack; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

9. Median time to fire after stacked target selected

<<<< Latency (in seconds) to fire following the gunner's selection of a target from the Target Stack; excludes latencies greater than 30 sec; available for CVCC vehicles only. One measure per CVCC crew per phase. >>>>

10. Number of times vehicle commander designated targets

<<<< Cumulative number of times the vehicle commander designated a target, slewing the gun tube to the specific direction of the target; available for CVCC vehicles only. One measure per CVCC vehicle commander per phase. >>>>

11. Median time to fire after vehicle commander designated target

<<<< Latency (in seconds) to fire following the designation of a target by the vehicle commander; excludes latencies greater than 15 sec; available for CVCC vehicles only. One measure per CVCC crew per phase. >>>>

CVCC CRITERION MEASURES

SCORING RULES

Accuracy of first CONTACT report

Based on reported "what" (type of vehicle) and "where" (grid location of enemy).

a. Scoring "What" (comparing reported vehicle type to actual enemy vehicles located within 500 m of reported location):

Matching type = 2 points
Non-matching type = 1 point
No enemy vehicle = 0

b. Scoring "Where" (based on distance from reported location to matching enemy vehicle or nearest enemy vehicle):

0-100 m = 3 points
100-250 m = 2 points
250-500 m = 1 point
>500 m = 0

c. Accuracy score = "Where" score + "What" score
[Max = 5 pts]

Timeliness of first CONTACT report

a. Scoring difference between CONTACT report time and first engagement firing time:

>4.5 min = 3 points
3-4.5 min = 2 points
1.5-3 min = 1 point
<0-1.5 min = 0

b. Max score = 3 points

Accuracy of SHELL reports

Based on reported "where."

a. Scoring distance from reported location to nearest shell impact point:

0-100 m = 3 points
100-250 m = 2 points
250-500 m = 1 point
>500 m = 0

b. Max score = 3 points

Accuracy of CALL FOR FIRE reports

Based on reported "what" (type of vehicle) and "where" (grid location of target).

a. Scoring "What" (comparing reported vehicle type to actual enemy vehicles located within 500 m of reported location):

Matching type = 2 points
Non-matching type = 1 point
No enemy vehicle = 0
Friendly vehicle within 100 m of reported location = 0

b. Scoring "Where" (based on distance from reported location to matching enemy vehicle or to nearest enemy vehicle):

0-100 m = 3 points
100-250 m = 2 points
250-500 m = 1 point
>500 m = 0
Friendly vehicle within 100 m of reported location = 0

c. Accuracy score = "Where" score + "What" score
[Max = 5 pts]

Paper map overlay usage index

Based on relative error in plotting tactical features. Separate scoring rules are used for each FRAGO-based mission.

a. Defensive FRAGO I:

1. Battle position score (based on proportion of plotted BP located within the correct boundaries):

75-100% = 3 points
50-75% = 2 points
<50% = 1 point
No plot = 0

2. Max score = 3 points

b. Defensive FRAGO II:

1. Battle position score [see above]

2. New west boundary score (based on plotted end points falling within 300 m of correct locations):

Both correct = 3 points
One correct = 2 points
None correct = 1 point
None plotted = 0

3. Max score = 6 points

c. Offensive FRAGO I:

1. Check Point score (based on plotted CPs falling within 300 m of correct locations):

Three correct = 3 points
Two correct = 2 points
0-1 correct = 1 point
None plotted = 0

2. Phase Line score (based on plotted end points falling within 300 m of correct locations):

Both correct = 3 points
One correct = 2 points
None correct = 1 point
None plotted = 0

3. Max score = 6 points

d. Offensive FRAGO II:

. Check Point score [see above]

2. Max score = 3 points

Map plot index (end-of-phase recall)

Based on error in plotting designated features on tactical map. Separate scoring rules are used for each FRAGO-based mission.

a. Defensive FRAGO I:

1. Own vehicle location score (based on distance between plotted location and correct location):

<200 m = 3 points
200-500 m = 2 points
>500 m = 1 point
No plot = 0

2. Minefield score (based on each plotted end point falling within 300 m of correct location):

Both correct = 3 points
One correct = 2 points
None correct = 1 point
None plotted = 0

3. Max score = 6 points

b. Defensive FRAGO II:

1. Own vehicle location score: [see above]

2. Western Boundary score: [see Minefield above]

3. Max score = 6 points

c. Offensive FRAGO I:

1. Checkpoint score (based on plotted CPs falling within 300 m of correct locations):

Three correct = 3 points
Two correct = 2 points
0-1 correct = 1 point
None plotted = 0

2. Minefield score: [see above]

3. Max score = 6 points

d. Offensive FRAGO II:

1. Phase Line FORD score: [see Minefield above]

2. Phase Line LISA score: [see Minefield above]

3. Max score = 6 points

CVCC COMPOSITE MEASURES

SCORING RULES

Co Cdr's FRAGO index

Based on accuracy and timeliness of the FRAGO transmitted by the company commander.

a. Scoring accuracy, based on matching or equivalent elements in the company commander's FRAGO compared to the FRAGO transmitted by the Bn S3.

	Defense	Offense
"What" elements =	1 point (ea of 4)	2 points (ea of 2)
"When" element =	3 points	N/A
"Where" element =	4 points	1 point (ea of 4)
"Why" elements =	1 point (ea of 2)	1 point (ea of 2)
"How" elements =	N/A	1 point (ea of 4)
Max accuracy =	13 points	14 points

b. Scoring timeliness, based on elapsed time from Bn FRAGO transmission to start of sustained movement in executing mission (median of "on-the-move" times for four primary company elements - three platoons plus company commander):

1. Defensive scenario:

0-7 min = 3 points
7-11 min = 2 points
11-15 min = 1 point
>15 min = 0

2. Offensive scenario:

11-14.5 min = 3 points
7.5-11 or 14.5-18 = 2 points
4-7.5 or 18-21.5 = 1 point
<4 or >21.5 = 0

c. Effectiveness score = Accuracy score + Timeliness score

d. Max scores:
Max score (Defense) = 16 points
Max score (Offense) = 17 points

Combined index for first CONTACT report

Based on integrating CONTACT report accuracy and CONTACT report timeliness scores. Both accuracy and timeliness scoring rules are specified under criterion scoring procedures.

a. Effectiveness score = Accuracy score + Timeliness score

b. Max score = 8 points

SPOT report index

Based on accuracy of aggregate number of enemy vehicles each platoon reported killed.

a. Scoring vehicle type error (based on absolute value of differences between number of identified enemy vehicles reported killed and those actually killed, summed across vehicle types):

1. Defensive scenario:
   0-4 = 3 points
   5-8 = 2 points
   9-12 = 1 point
   >12 = 0

2. Offensive scenario:
   0-1 = 3 points
   2-3 = 2 points
   4-5 = 1 point
   >5 = 0

b. Scoring overall error (based on subtracting the total number of enemy vehicles reported killed, regardless of type, from the total number actually killed):

1. Defensive scenario:
   0-4 = 3 points
   5-8 = 2 points
   9-12 = 1 point
   >12 = 0

2. Offensive scenario:
   0-1 = 3 points
   2-3 = 2 points
   4-5 = 1 points
   >5 = 0

c. Effectiveness score = Veh type error score +
   Overall error score
   [Max = 6 points]

Appendix D

Data Tables for the Intra-Vehicular Command and Control (IVCC) Configuration

Data Tables for the Intra-Vehicular Command and Control (IVCC) Configuration

The experimental configuration known as the Intra-Vehicular Command and Control (IVCC) system represented an alternative level of automated command, control and communication functionality. Incorporating alternative versions of both the Command and Control Display (CCD) and the Commander's Independent Thermal Viewer (CITV), it was originally intended for comparison with the Combat Vehicle Command and Control (CVCC) configuration. However, the IVCC design features did not include a radio interface unit, which would be needed to support digital bursting of information from one vehicle to another. In the middle of the data collection phase for the evaluation, the Army reached a decision that the radio interface unit was a supportable requirement. Since this decision greatly limited the applicability of the IVCC data, the condition was eliminated from the design. This appendix presents summary data only from the IVCC equipped units.

The facilities, materials, and procedures for training and testing were identical to those used with the CVCC and M1 Baseline companies. The weekly training and testing schedule was the same as that used for the CVCC condition. The functional capabilities of the CCD and CITV were somewhat different from those of the CVCC configuration; the differences will be listed shortly.

Participants

The participants manning the IVCC equipped companies were 105 U.S. Army personnel, including 20 commissioned officers, 34 noncommissioned officers, and 51 enlisted personnel. They were furnished by the Fort Knox armored brigade and cavalry regiment which provided participants for the CVCC and M1 Baseline conditions. In addition, some of the commissioned officers had just graduated from the Armor Officer Advanced Course or the Armor Officer Basic Course. The key biographical characteristics of the participants are summarized in Table D-1.

The configuration of the test company was identical to that used for the CVCC and M1 Baseline conditions.

Equipment Configuration

The CITV capabilities in the IVCC condition were the same as in the CVCC configuration, except for the absence of the independent laser range finder, the IFF function, and the Target Stack feature. In addition, the own vehicle icon had a stationary hull, with other features of the icon unchanged.

Table D-2 lists the CCD capabilities of the IVCC configuration, which differed substantially from the CVCC system.

Table D-1

Summary of Biographical Measures for IVCC Participants

Measure	Range (N=105)	Mean,TCs (n=35)	Mean, all (N=105)
Age (years)	18 - 46	28.2	24.4
Time in armor (months)	5 - 187	73.2	51.6
Experience on M1 (months)	0 - 91	20.4	19.5
Experience in TO&E units (yrs)	0 - 13	4.6	3.7
Time on SIMNET (hours)	0 - 400	56.1	46.2

Table D-2

Capabilities of the IVCC CCD Configuration

Navigation

- Grid map
- Own vehicle location & heading (digital)
- Own vehicle icon (position & direction)
- Route waypoint icons
- Driver's steer-to display (analog & digital)

Communications

- LRF input to reports (GPS only)
- Preparation of digital reports

General characteristics

- Thumb control
- Monochrome display

Data Tables

The standard set of performance measures developed for the evaluation was used to quantify the performance of IVCC equipped companies. Appendix C presents the definitions of all measures and summarizes the scoring rules used for criterion and composite measures. Summary data tables for the IVCC condition follow.

Table D-3

Mission Performance Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Time to complete phase (min)	62.0 (14.0) n=5	47.7 (11.2) n=5	46.8 (5.8) n=4
% enemy vehicles killed	73.3 (4.6) n=5	100 (0) n=5	95.0 (5.8) n=4
% kills by manned vehicles	32.4 (8.6) n=4	77.6 (11.4) n=5	55.2 (.58) n=3
# manned losses	3.2 (4.6) n=4	0 (0) n=5	2.3 (2.1) n=3
# tethered losses	.20 (.45) n=5	.20 (.45) n=5	0 (0) n=3
Losses/kill, manned vehicles	.52 (.70) n=5	0 (0) n=5	.32 (.42) n=3

Table D-4

Mission Performance Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Time to complete phase (min)	53.2 (8.1) n=5	55.0 (10.0) n=5	48.1 (1.9) n=4
% enemy vehicles killed	62.3 (15.2) n=5	70.5 (23.0) n=5	78.0 (6.6) n=4
% kills by manned vehicles	30.0 (6.8) n=4	69.4 (8.2) n=3	28.7 (9.6) n=3
# manned losses	14.8 (17.2) n=4	18.3 (5.1) n=3	10.7 (4.9) n=3
# tethered losses	2.6 (1.5) n=5	2.4 (1.8) n=5	3.2 (1.3) n=4
Losses/kill, manned vehicles	1.10 (1.6) n=4	1.77 (1.5) n=4	.56 (.20) n=3

Table D-5

Information Acquisition and Communication Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
# named rpts originated	8.10 (4.8) n=20	3.70 (1.8) n=20	4.62 (3.6) n=16
# "other" radio msgs/hr	1.45 (2.0) n=20	1.55 (1.8) n=20	1.38 (1.4) n=16
# requests to clarify FRAGOs and INTEL rpts	2.00 (3.4) n=5	4.60 (2.5) n=5	4.00 (1.6) n=4

Note. See Table D-7 for report accuracy measures (CONTACT, SHELL, and CALL FOR FIRE).

Table D-6

Information Acquisition and Communication Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
# named rpts originated	6.95 (3.8) n=20	6.75 (3.4) n=20	5.00 (2.9) n=16
# "other" radio msgs/hr	1.40 (1.2) n=20	1.60 (1.8) n=20	1.00 (1.3) n=16
# requests to clarify FRAGOs and INTEL rpts	.40 (.89) n=5	1.80 (2.2) n=5	1.00 (1.2) n=4

Note. See Table D-8 for report accuracy measures (CONTACT, SHELL and CALL FOR FIRE).

Table D-7

Tactical Assessment and Planning Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Time to relay FRAGO (Co Cdr) (min)	---	3.57 (2.2) n=5	4.97 (1.3) n=4
FRAGO index (Co Cdr) (Max = 17)	---	8.80 (2.3) n=5	7.25 (2.1) n=4
CONTACT rpt accuracy (Max = 5)	.80 (1.8) n=5	1.60 (2.2) n=5	2.33 (2.1) n=3
SHELL rpt accuracy (Max = 3)	.46 (.61) n=5	1.33 (.29) n=3	1.13 (1.2) n=3
CALL FOR FIRE accuracy (Max = 5)	1.50 (.87) n=3	0 (0) n=1	.67 (1.2) n=3
CONTACT rpt timeliness (Max = 3)	1.00 (1.4) n=5	0 (0) n=5	1.00 (1.7) n=3
Map plot index (Max = 6)	---	2.09 (1.9) n=35	1.50 (1.9) n=28

Table D-8

Tactical Assessment and Planning Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Time to relay FRAGO (Co Cdr) (min)	---	3.55 (2.8) n=5	5.35 (3.1) n=4
FRAGO index (Co Cdr) (Max = 15)	---	5.00 (2.9) n=5	5.75 (3.5) n=4
CONTACT rpt accuracy (Max = 5)	1.00 (2.0) n=4	1.40 (1.9) n=5	1.75 (1.3) n=4
SHELL rpt accuracy (Max = 3)	.50 (.64) n=4	1.33 (.85) n=5	2.04 (1.2) n=4
CALL FOR FIRE accuracy (Max = 5)	.42 (.84) n=4	.92 (1.3) n=4	1.18 (.94) n=4
CONTACT rpt timeliness (Max = 3)	1.50 (1.7) n=4	.60 (1.3) n=5	0 (0) n=4
Map plot index (Max = 6)	---	2.57 (1.2) n=35	3.00 (1.3) n=28

Table D-9

Operational Control of Unit Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
% rounds fired by Co Cdr & Plt Ldrs	16.4 (20.7) n=16	12.0 (10.6) n=20	10.5 (10.8) n=12
Co Cdr distance from company center of mass	367.9 (102) n=5	436.3 (292) n=5	568.2 (517) n=4
% time company dispersion >600 m	70.8 (44.5) n=4	60.4 (39.1) n=5	22.0 (24.1) n=3
% time 2nd plt dispersion >200 m	48.7 (34.6) n=4	54.8 (31.4) n=5	19.4 (19.2) n=3
% time company dispersion <300 m	15.2 (22.7) n=4	19.6 (37.8) n=5	33.8 (50.2) n=3
% time 2nd plt dispersion <100 m	17.0 (10.8) n=4	17.9 (12.7) n=5	56.3 (8.1) n=3
# fratricide hits	.03 (.17) n=34	.03 (.17) n=35	.12 (.44) n=25

Table D-10

Operational Control of Unit Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
% rounds fired by Co Cdr & Plt Ldrs	16.7 (8.1) n=16	14.2 (7.8) n=12	16.1 (5.1) n=12
# fratricide hits	4.6 (11.5) n=34	0 (0) n=33	.04 (.19) n=27

Table D-11

Unit Positioning and Navigation Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Distance travelled (km)	21.8 (3.1) n=27	10.2 (1.2) n=28	10.7 (7.9) n=21
Fuel used (gal)	29.1 (4.5) n=27	15.6 (3.8) n=28	14.5 (2.7) n=21
Mean velocity (while moving) (km/hr)	32.7 (7.8) n=34	34.1 (8.8) n=35	36.4 (7.7) n=25
% time moving velocity >40 km/hr	33.2 (20.0) n=34	36.0 (24.2) n=35	39.7 (20.8) n=25
% time at halt	32.4 (9.4) n=34	59.0 (9.0) n=35	58.3 (11.7) n=25
# times vehicle out of sector	1.25 (2.3) n=35	.03 (.17) n=35	.32 (.98) n=28
Paper map overlay usage index (Max = 6)	---	1.85 (2.0) n=35	1.14 (1.3) n=28

Table D-12

Unit Positioning and Navigation Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Distance travelled (km)	5.4 (3.2) n=34	5.6 (2.1) n=33	9.8 (7.2) n=27
Fuel used (gal)	10.1 (4.1) n=34	10.8 (3.2) n=33	16.2 (2.6) n=27
Mean velocity (while moving) (km/hr)	38.7 (10.8) n=34	32.8 (10.9) n=33	38.8 (9.4) n=27
% time moving velocity >40 km/hr	52.4 (19.4) n=34	39.1 (22.9) n=33	48.4 (19.5) n=27
% time at halt	81.8 (15.4) n=34	81.1 (6.5) n=33	66.8 (8.2) n=27
# times vehicle out of sector	.94 (2.3) n=35	.69 (.18) n=35	.71 (1.9) n=28
Paper map overlay usage index (Max = 3)	---	.54 (.98) n=35	.86 (1.3) n=28

Table D-13

Target Acquisition and Engagement Measures for Offensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Maximum lasing range (m)	2827 (850) n=34	2931 (877) n=34	2572 (816) n=25
Median target hit range (m)	1669 (751) n=20	1232 (914) n=25	899 (449) n=20
% targets hit >2200 m	24.2 (37.2) n=20	23.7 (40.5) n=25	1.4 (4.4) n=20
Median target kill range (m)	1243 (672) n=15	1312 (926) n=23	938 (492) n=12
% targets killed >2200 m	8.9 (18.8) n=15	26.1 (41.6) n=23	0 (0) n=12
# hits taken by manned vehicles	1.12 (2.4) n=34	.20 (.87) n=35	5.24 (8.2) n=25

Table D-14

Target Acquisition and Engagement Measures for Defensive Scenario, by Phase: Means and Standard Deviations (in parentheses)

Measure	Phase I	Phase II	Phase III
Maximum lasing range (m)	3228 (669) n=34	3108 (540) n=33	3224 (613) n=27
Median target hit range (m)	1731 (559) n=29	1882 (316) n=28	1709 (472) n=26
% targets hit >2200 m	22.8 (28.8) n=29	21.2 (29.5) n=28	25.3 (26.1) n=26
Median target kill range (m)	1777 (578) n=28	1727 (473) n=23	1683 (483) n=24
% targets killed >2200 m	27.6 (33.4) n=28	16.7 (28.4) n=23	22.6 (32.2) n=24
# hits taken by manned vehicles	24.0 (53.5) n=34	12.2 (24.0) n=33	20.6 (53.9) n=27

Appendix E

Summary Tables of Statistical Analyses

ANOVA: TIME TO COMPLETE MISSION X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

- - - - - - - - - - -

Cell Means and Standard Deviations
Variable .. TIMEP1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	61.957	13.233	5
CONDIT	M1	89.632	9.531	4
For entire sample		74.257	18.286	9

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Variable .. TIMEP2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	34.865	7.887	5
CONDIT	M1	54.796	9.701	4
For entire sample		43.723	13.294	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	1414.32	7	202.05		
CONSTANT	64668.21	1	64668.21	320.07	.000
CONDIT	2518.11	1	2518.11	12.46	.010

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	89.77	7	12.82		
PHASE	4261.16	1	4261.16	332.25	.000
CONDIT BY PHASE	66.66	1	66.66	5.20	.057

ANOVA: TIME TO COMPLETE MISSION x COND x PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. TIMEP1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	51.306	7.552	5
CONDIT	M1	60.886	8.129	4
For entire sample		55.564	8.876	9

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Variable .. TIMEP2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	43.270	8.811	5
CONDIT	M1	55.545	11.538	4
For entire sample		48.725	11.428	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	557.61	7	79.66		
CONSTANT	49470.79	1	49470.79	621.03	.000
CONDIT	530.76	1	530.76	6.66	.036

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	578.64	7	82.66		
PHASE	198.84	1	198.84	2.41	.165
CONDIT BY PHASE	8.07	1	8.07	.10	.764

ANOVA: % ENEMY KILLED BY BLUFOR BY COND BY PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. MP3P1 PERCENT EN BY BLU - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	95.556	4.648	5
CONDIT	M1	73.444	21.663	4
For entire sample		85.728	17.961	9

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Variable .. MP3P2 PERCENT EN BY BLU - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	98.333	3.727	5
CONDIT	M1	100.000	.000	4
For entire sample		99.074	2.778	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	784.17	7	112.02		
CONSTANT	149926.42	1	149926.42	1338.33	.000
CONDIT	464.42	1	464.42	4.15	.081

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	765.65	7	109.38		
PHASE	956.05	1	956.05	8.74	.021
CONDIT BY PHASE	628.20	1	628.20	5.74	.048

ANOVA: % ENEMY KILLED BY BLUFOR BY COND BY PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. MP3P1 PERCENT EN BY BLU - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	56.923	18.375	5
CONDIT	M1	71.635	22.227	4
For entire sample		63.462	20.352	9

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Variable .. MP3P2 PERCENT EN BY BLU - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	73.333	12.418	5
CONDIT	M1	80.952	10.287	4
For entire sample		76.720	11.528	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	2550.11	7	364.30		
CONSTANT	88889.32	1	88889.32	244.00	.000
CONDIT	554.06	1	554.06	1.52	.257

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	1216.78	7	173.83		
PHASE	735.48	1	735.48	4.23	.079
CONDIT BY PHASE	55.89	1	55.89	.32	.588

MANOVA ON MP4 MP6 MP7B X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. MP4P1 PERCENT EN LOSSES BY MANNED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	32.108	15.932	5
CONDITION	M1	32.077	17.289	4
For entire sample		32.094	15.460	9

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Variable .. MP4P2 PERCENT EN LOSSES BY MANNED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	79.550	20.752	5
CONDITION	M1	63.688	11.086	4
For entire sample		72.500	18.202	9

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Variable .. MP6P1 MANNED LOSSES - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	2.800	3.271	5
CONDITION	M1	4.750	2.986	4
For entire sample		3.667	3.122	9

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Variable .. MP6P2 MANNED LOSSES - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	.200	.447	5
CONDITION	M1	1.500	1.915	4
For entire sample		.778	1.394	9

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Variable .. MP7BP1 MANNED LOSS/KILL - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	.379	.467	5
CONDITION	M1	1.426	2.383	4
For entire sample		.844	1.595	9

Variable .. MP7BP2 MANNED LOSS/KIL - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	.000	.000	5
CONDITION	M1	.056	.111	4
For entire sample		.025	.074	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.35568	.92004	3.00	5.00	.495
Hotellings	.55202	.92004	3.00	5.00	.495
Wilks	.64432	.92004	3.00	5.00	.495
Roys	.35568				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.95236	33.31634	3.00	5.00	.001
Hotellings	19.98981	33.31634	3.00	5.00	.001
Wilks	.04764	33.31634	3.00	5.00	.001
Roys	.95236				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .01193
Chi-square approx. = 25.34081 with 5 D. F.
Significance = .000

Greenhouse-Geisser Epsilon = .37934
Huynh-Feldt Epsilon = .46867
Lower-bound Epsilon = .33333

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.54804	2.02098	3.00	5.00	.230
Hotellings	1.21259	2.02098	3.00	5.00	.230
Wilks	.45196	2.02098	3.00	5.00	.230
Roys	.54804				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.96793	50.29974	3.00	5.00	.000
Hotellings	30.17985	50.29974	3.00	5.00	.000
Wilks	.03207	50.29974	3.00	5.00	.000
Roys	.96793				

MANOVA ON MP4 MP6 MP7B X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. MP4P1 PERCENT EN LOSSES BY MANNED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	30.644	11.607	5
CONDITION	M1	31.356	7.714	4
For entire sample		30.961	9.477	9

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Variable .. MP4P2 PERCENT EN LOSSES BY MANNED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	77.302	14.662	5
CONDITION	M1	56.508	7.078	4
For entire sample		68.060	15.696	9

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Variable .. MP6P1 MANNED LOSSES - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	14.000	9.487	5
CONDITION	M1	28.000	14.967	4
For entire sample		20.222	13.544	9

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Variable .. MP6P2 MANNED LOSSES - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	10.600	7.232	5
CONDITION	M1	12.250	6.238	4
For entire sample		11.333	6.442	9

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Variable .. MP7BP1 MANNED LOSS/KILL - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	.700	.284	5
CONDITION	M1	1.370	.650	4
For entire sample		.998	.569	9

Variable .. MP7BP2 MANNED LOSS/KIL - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	.831	.580	5
CONDITION	M1	1.136	.540	4
For entire sample		.967	.551	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.45801	1.40841	3.00	5.00	.343
Hotellings	.84504	1.40841	3.00	5.00	.343
Wilks	.54199	1.40841	3.00	5.00	.343
Roys	.45801				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.98205	91.17298	3.00	5.00	.000
Hotellings	54.70379	91.17298	3.00	5.00	.000
Wilks	.01795	91.17298	3.00	5.00	.000
Roys	.98205				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .00401
Chi-square approx. = 31.58141 with 5 D. F.
Significance = .000

Greenhouse-Geisser Epsilon = .64886
Huynh-Feldt Epsilon = 1.00000
Lower-bound Epsilon = .33333

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.57919	2.29395	3.00	5.00	.195
Hotellings	1.37637	2.29395	3.00	5.00	.195
Wilks	.42081	2.29395	3.00	5.00	.195
Roys	.57919				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 1 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.92229	19.78136	3.00	5.00	.003
Hotellings	11.86882	19.78136	3.00	5.00	.003
Wilks	.07771	19.78136	3.00	5.00	.003
Roys	.92229				

ANOVA ON MP5 X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. MP5P1 TETHERED LOSSES - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	2.000	.707	5
CONDIT	M1	3.750	1.500	4
For entire sample		2.778	1.394	9

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Variable .. MP5P2 TETHERED LOSSES - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	1.400	1.673	5
CONDIT	M1	2.000	.816	4
For entire sample		1.667	1.323	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	10.97	7	1.57		
CONSTANT	93.03	1	93.03	59.33	.000
CONDIT	6.14	1	6.14	3.91	.088

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	10.97	7	1.57		
PHASE	6.14	1	6.14	3.91	.088
CONDIT BY PHASE	1.47	1	1.47	.94	.365

TITLE MANOVA: IAC1 & IAC2 X COND X PHASE (RPTD).
SUBTITLE OFFENSIVE SCENARIO (CCs & PLs ONLY).

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Cell Means and Standard Deviations

Variable .. IAC1P1 IAC1: # OF NAMED RPTS SENT - P1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	5.550	4.371	20
COND	M1	8.125	4.500	16
For entire sample		6.694	4.553	36

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Variable .. IAC1P2 IAC1: # OF NAMED RPTS SENT - P2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	3.700	1.658	20
COND	M1	3.563	2.128	16
For entire sample		3.639	1.854	36

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Variable .. IAC2P1 IAC2: # OF OTHER RPTS SENT - P1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	1.150	1.694	20
COND	M1	3.188	4.608	16
For entire sample		2.056	3.422	36

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Variable .. IAC2P2 IAC2: # OF OTHER RPTS SENT - P2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	3.850	3.774	20
COND	M1	4.938	5.039	16
For entire sample		4.333	4.349	36

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* * ANALYSIS OF VARIANCE DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. COND

Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.06797	1.20330	2.00	33.00	.313
Hotellings	.07293	1.20330	2.00	33.00	.313
Wilks	.93203	1.20330	2.00	33.00	.313
Roys	.06797				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
CONSTANT	26.40625	519.59375	26.40625	15.28217	1.72791	.197
T3	43.40278	783.87500	43.40278	23.05515	1.88256	.179

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.79005	62.09176	2.00	33.00	.000
Hotellings	3.76314	62.09176	2.00	33.00	.000
Wilks	.20995	62.09176	2.00	33.00	.000
Roys	.79005				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
CONSTANT	1948.35069	519.59375	1948.35069	15.28217	127.49176	.000
T3	765.62500	783.87500	765.62500	23.05515	33.20842	.000

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .99456
Chi-square approx. = .18017 with 2 D. F.
Significance = .914

Greenhouse-Geisser Epsilon = .99458
Huynh-Feldt Epsilon = 1.00000
Lower-bound Epsilon = .50000

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EFFECT .. COND BY PHASE
Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.12596	2.37792	2.00	33.00	.108
Hotellings	.14412	2.37792	2.00	33.00	.108
Wilks	.87404	2.37792	2.00	33.00	.108
Roys	.12596				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
PHASE	32.70069	267.24375	32.70069	7.86011	4.16034	.049
T4	4.01111	240.60000	4.01111	7.07647	.56682	.457

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.50010	16.50630	2.00	33.00	.000
Hotellings	1.00038	16.50630	2.00	33.00	.000
Wilks	.49990	16.50630	2.00	33.00	.000
Roys	.50010				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
PHASE	182.75625	267.24375	182.75625	7.86011	23.25111	.000
T4	88.01111	240.60000	88.01111	7.07647	12.43715	.001

TITLE MANOVA: IAC1 & IAC2 X COND X PHASE (RPTD)
SUBTITLE DEFENSIVE SCENARIO (CCs & PLs ONLY).

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Cell Means and Standard Deviations

Variable .. IAC1P1 IAC1: # OF NAMED RPTS SENT - P1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	7.000	5.858	20
COND	M1	6.188	3.468	16
For entire sample		6.639	4.894	36

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Variable .. IAC1P2 IAC1: # OF NAMED RPTS SENT - P2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	5.400	4.057	20
COND	M1	4.375	3.686	16
For entire sample		4.944	3.876	36

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Variable .. IAC2P1 IAC2: # OF OTHER RPTS SENT - P1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	2.150	3.329	20
COND	M1	2.438	2.555	16
For entire sample		2.278	2.972	36

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Variable .. IAC2P2 IAC2: # OF OTHER RPTS SENT - P2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVC2	1.100	1.210	20
COND	M1	1.313	1.352	16
For entire sample		1.194	1.261	36

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* * ANALYSIS OF VARIANCE DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. COND

Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.02049	.34518	2.00	33.00	.711
Hotellings	.02092	.34518	2.00	33.00	.711
Wilks	.97951	.34518	2.00	33.00	.711
Roys	.02049				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
CONSTANT	15.00625	1028.36875	15.00625	30.24614	.49614	.486
T3	1.11111	230.37500	1.11111	6.77574	.16398	.688

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.75032	49.58358	2.00	33.00	.000
Hotellings	3.00507	49.58358	2.00	33.00	.000
Wilks	.24968	49.58358	2.00	33.00	.000
Roys	.75032				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
CONSTANT	2343.45069	1028.36875	2343.45069	30.24614	77.47933	.000
T3	217.77778	230.37500	217.77778	6.77574	32.14083	.000

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Tests involving 'PHASE' Within-Subject Effect.
Mauchly sphericity test, W = .80820
Chi-square approx. = 7.02738 with 2 D. F.
Significance = .030

Greenhouse-Geisser Epsilon = .83906
Huynh-Feldt Epsilon = .90361
Lower-bound Epsilon = .50000

EFFECT .. COND BY PHASE

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Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.00072	.01191	2.00	33.00	.988
Hotellings	.00072	.01191	2.00	33.00	.988
Wilks	.99928	.01191	2.00	33.00	.988
Roys	.00072				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
PHASE	.20069	320.61875	.20069	9.42996	.02128	.885
T4	.02500	133.35000	.02500	3.92206	.00637	.937

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 0, N = 15 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.21552	4.53315	2.00	33.00	.018
Hotellings	.27474	4.53315	2.00	33.00	.018
Wilks	.78448	4.53315	2.00	33.00	.018
Roys	.21552				

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Univariate F-tests with (1,34) D. F.

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	Sig. of F
PHASE	51.75625	320.61875	51.75625	9.42996	5.48849	.025
T4	21.02500	133.35000	21.02500	3.92206	5.36070	.027

ANOVAs ON IAC 14A - 14C, BY DUTY POSITION
OFFENSIVE SCENARIO - CVCC ONLY

Summaries of IAC14A PERCENT VISION BLOCKS

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			13.142857	11.834395	28
POSITION	1	Co Cdr	8.250000	6.994045	4
POSITION	2	Plt Ldr	7.750000	3.744693	12
POSITION	3	TC	20.166667	14.904748	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	1036.7619	2	518.3810	4.7217	.0182
Within Groups	2744.6667	25	109.7867		

Summaries of IAC14B PERCENT GPSE

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			6.785714	5.717790	28
POSITION	1	Co Cdr	1.500000	2.380476	4
POSITION	2	Plt Ldr	8.083333	6.359793	12
POSITION	3	TC	7.250000	5.101248	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	134.5476	2	67.2738	2.2480	.1265
Within Groups	748.1667	25	29.9267		

Summaries of IAC14C PERCENT CITV

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			37.428571	18.168814	28
POSITION	1	Co Cdr	21.500000	26.938201	4
POSITION	2	Plt Ldr	42.500000	8.618163	12
POSITION	3	TC	37.666667	20.437636	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	1324.1905	2	662.0952	2.1812	.1339
Within Groups	7588.6667	25	303.5467		

Summaries of IAC14D PERCENT CCD

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			42.285714	19.971938	28
POSITION	1	Co Cdr	68.750000	30.923292	4
POSITION	2	Plt Ldr	41.666667	9.374369	12
POSITION	3	TC	34.083333	17.375313	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	3613.3810	2	1806.6905	6.3115	.0060
Within Groups	7156.3333	25	286.2533		

Eta = .5792 Eta Squared = .3355

ANOVAs ON IAC 14A - 14C, BY DUTY POSITION
DEFENSIVE SCENARIO - CVCC ONLY

Summaries of IAC14A PERCENT VISION BLOCKS

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			14.392857	14.652365	28
POSITION	1	Co Cdr	8.500000	7.937254	4
POSITION	2	Plt Ldr	8.250000	5.241877	12
POSITION	3	TC	22.500000	18.889632	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	1380.4286	2	690.2143	3.9072	.0334
Within Groups	4416.2500	25	176.6500		

Summaries of IAC14B PERCENT GPSE

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			7.750000	5.358448	28
POSITION	1	Co Cdr	2.750000	2.061553	4
POSITION	2	Plt Ldr	7.000000	4.786344	12
POSITION	3	TC	10.166667	5.507571	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	176.8333	2	88.4167	3.6938	.0393
Within Groups	598.4167	25	23.9367		

Summaries of IAC14C PERCENT CITV

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			40.214286	18.595812	28
POSITION	1	Co Cdr	15.000000	9.128709	4
POSITION	2	Plt Ldr	50.416667	10.966547	12
POSITION	3	TC	38.416667	18.908672	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	3830.8810	2	1915.4405	8.6973	.0014
Within Groups	5505.8333	25	220.2333		

Summaries of IAC14D PERCENT CCD

Variable	Value	Label	Mean	Std Dev	Cases
For Entire Population			38.000000	19.586465	28
POSITION	1	Co Cdr	73.750000	13.768926	4
POSITION	2	Plt Ldr	35.083333	13.720975	12
POSITION	3	TC	29.000000	11.801387	12

Analysis of Variance

Source	Sum of Squares	D.F.	Mean Square	F	Sig.
Between Groups	6186.3333	2	3093.1667	18.5368	.0000
Within Groups	4171.6667	25	166.8667		

ANOVA: TIME TO RELAY FRAGO X COND
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. TAPP6 TIME TO RELAY FRAGO

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	2.456	4.427	5
COND	M1	5.725	2.723	4
For entire sample		3.909	3.943	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for TAPP6 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	100.65	7	14.38		
CONSTANT	148.75	1	148.75	10.35	.015
COND	23.74	1	23.74	1.65	.240

ANOVA: TIME TO RELAY FRAGO X COND
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. TAPP6 TIME TO RELAY FRAGO

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	1.693	1.379	5
COND	M1	10.203	9.426	4
For entire sample		5.476	7.375	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for TAPP6 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	274.18	7	39.17		
CONSTANT	314.51	1	314.51	8.03	.025
COND	160.93	1	160.93	4.11	.082

ANOVA: FRAGO INDEX X COND
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. TAPP7 FRAGO INDEX

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	9.600	.548	5
COND	M1	6.750	3.096	4
For entire sample		8.333	2.449	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for TAPP7 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	29.95	7	4.28		
CONSTANT	594.05	1	594.05	138.84	.000
COND	18.05	1	18.05	4.22	.079

ANOVA: FRAGO INDEX X COND
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. TAPP7 FRAGO INDEX

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	11.800	1.483	5
COND	M1	8.250	1.500	4
For entire sample		10.222	2.333	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Significance for TAPP7 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	15.55	7	2.22		
CONSTANT	893.34	1	893.34	402.15	.000
COND	28.01	1	28.01	12.61	.009

ANOVA: CONTACT REPORT ACCURACY X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CON_AP1 CONTACT ACCURACY - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	5.000	.000	5
COND	5	1.500	1.732	4
For entire sample		3.444	2.128	9

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Variable .. CON_AP2 CONTACT ACCURACY - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	4.800	.447	5
COND	5	.750	1.500	4
For entire sample		3.000	2.345	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	3.77	7	.54		
CONSTANT	161.34	1	161.34	299.17	.000
COND	63.34	1	63.34	117.44	.000

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	12.77	7	1.82		
PHASE	1.00	1	1.00	.55	.483
COND BY PHASE	.34	1	.34	.18	.681

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ANOVA: CONTACT REPORT ACCURACY X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. CON_AP1 CONTACT ACCURACY - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	4.000	2.236	5
COND	5	.000	.000	4
For entire sample		2.222	2.635	9

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Variable .. CON_AP2 CONTACT ACCURACY - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	2.800	2.588	5
COND	5	1.250	2.500	4
For entire sample		2.111	2.522	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	21.78	7	3.11		
CONSTANT	72.00	1	72.00	23.15	.002
COND	34.22	1	34.22	11.00	.013

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	43.77	7	6.25		
PHASE	.00	1	.00	.00	.984
COND BY PHASE	6.67	1	6.67	1.07	.336

ANOVA: CALL FOR FIRE REPORT ACCURACY X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CFFP1 CFF - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	1.250	1.768	2
COND	5	.000	.000	1
For entire sample		.833	1.443	3

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Variable .. CFFP2 CFF - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	1.835	2.595	2
COND	5	.000	.000	1
For entire sample		1.223	2.119	3

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	9.52	1	9.52		
CONSTANT	3.17	1	3.17	.33	.667
COND	3.17	1	3.17	.33	.667

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	.34	1	.34		
PHASE	.11	1	.11	.33	.667
COND BY PHASE	.11	1	.11	.33	.667

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ANOVA: CALL FOR FIRE REPORT ACCURACY X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CFFP1 CFF - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	2.305	1.817	4
COND	5	1.000	.000	1
For entire sample		2.044	1.678	5

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Variable .. CFFP2 CFF - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	2.583	1.177	4
COND	5	.000	.000	1
For entire sample		2.066	1.541	5

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	4.97	3	1.66		
CONSTANT	13.87	1	13.87	8.37	.063
COND	6.05	1	6.05	3.65	.152

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	9.09	3	3.03		
PHASE	.21	1	.21	.07	.810
COND BY PHASE	.65	1	.65	.22	.674

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ANOVA: CONTACT REPORT TIMELINESS X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CON_TP1 CONTACT TIMELINESS - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	2.400	.894	5
COND	5	.000	.000	3
For entire sample		1.500	1.414	8

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Variable .. CON_TP2 CONTACT TIMELINESS - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	.400	.548	5
COND	5	.667	1.155	3
For entire sample		.500	.756	8

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	3.73	6	.62		
CONSTANT	11.27	1	11.27	18.11	.005
COND	4.27	1	4.27	6.86	.040

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	3.33	6	.56		
PHASE	1.67	1	1.67	3.00	.134
COND BY PHASE	6.67	1	6.67	12.00	.013

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ANOVA: CONTACT REPORT TIMELINESS X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. CON_TP1 CONTACT TIMELINESS - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	.200	.447	5
COND	5	.000	.000	4
For entire sample		.111	.333	9

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Variable .. CON_TP2 CONTACT TIMELINESS - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	.000	.000	5
COND	5	.000	.000	4
For entire sample		.000	.000	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	.40	7	.06		
CONSTANT	.04	1	.04	.78	.407
COND	.04	1	.04	.78	.407

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	.40	7	.06		
PHASE	.04	1	.04	.78	.407
COND BY PHASE	.04	1	.04	.78	.407

ANOVA: CONTACT REPORT INDEX X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CON_EP1 CONTACT EFFECTI - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	7.400	.894	5
COND	5	1.500	1.732	4
For entire sample		4.778	3.346	9

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Variable .. CON_EP2 CONTACT EFFECTI - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	5.200	.837	5
COND	5	1.250	2.500	4
For entire sample		3.444	2.651	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	8.97	7	1.28		
CONSTANT	261.80	1	261.80	204.19	.000
COND	107.80	1	107.80	84.08	.000

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	24.77	7	3.54		
PHASE	6.67	1	6.67	1.88	.212
COND BY PHASE	4.22	1	4.22	1.19	.311

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ANOVA: CONTACT REPORT INDEX X COND X PHASE (RPTD) 11/23/90
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. CON_EP1 CONTACT EFFECTI - PHASE1

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	4.200	2.387	5
COND	5	.000	.000	4
For entire sample		2.333	2.784	9

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Variable .. CON_EP2 CONTACT EFFECTI - PHASE2

FACTOR	CODE	Mean	Std. Dev.	N
COND	4	2.800	2.588	5
COND	5	1.250	2.500	4
For entire sample		2.111	2.522	9

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	20.37	7	2.91		
CONSTANT	75.63	1	75.63	25.98	.001
COND	36.74	1	36.74	12.62	.009

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	47.97	7	6.85		
PHASE	.03	1	.03	.00	.954
COND BY PHASE	7.80	1	7.80	1.14	.321

ANOVA: SPOT INDEX X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. SPOTP1 SPOT EFF. - PHASE 1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	2.750	2.734	12
COND	M1	4.667	2.062	9
For entire sample		3.571	2.599	21

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Variable .. SPOTP2 SPOT EFF. - PHASE 2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	1.917	1.832	12
COND	M1	4.111	1.537	9
For entire sample		2.857	2.007	21

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	100.11	19	5.27		
CONSTANT	464.79	1	464.79	88.21	.000
COND	43.46	1	43.46	8.25	.010

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	71.94	19	3.79		
PHASE	4.96	1	4.96	1.31	.267
COND BY PHASE	.20	1	.20	.05	.821

ANOVA: SPOT INDEX X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. SPOTP1 SPOT EFF. - PHASE 1

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	4.667	1.799	15
COND	M1	3.167	2.563	6
For entire sample		4.238	2.095	21

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Variable .. SPOTP2 SPOT EFF. - PHASE 2

FACTOR	CODE	Mean	Std. Dev.	N
COND	CVCC	5.133	1.246	15
COND	M1	2.500	2.168	6
For entire sample		4.381	1.936	21

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests of Between-Subjects Effects.

Tests of Significance for CONSTANT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	66.87	19	3.52		
CONSTANT	512.61	1	512.61	145.66	.000
COND	36.61	1	36.61	10.40	.004

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Tests involving 'PHASE' Within-Subject Effect.

Tests of Significance for PHASE using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN CELLS	56.53	19	2.98		
PHASE	.09	1	.09	.03	.867
COND BY PHASE	2.75	1	2.75	.93	.348

MANOVA ON OCU3, OCU4, OCU5, OCU7 X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. OCU3P1 CC DIST FROM UNIT COM - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	684.572	388.296	5
CONDITION	M1	479.092	244.131	4
For entire sample		593.248	330.855	9

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Variable .. OCU3P2 CC DIST FROM UNIT COM - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	719.493	443.957	5
CONDITION	M1	407.537	233.824	4
For entire sample		580.846	382.209	9

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Variable .. OCU4P1 PERCENT CO > 600M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	89.376	10.055	5
CONDITION	M1	66.458	36.659	4
For entire sample		79.190	26.465	9

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Variable .. OCU4P2 PERCENT CO > 600M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	96.250	8.385	5
CONDITION	M1	71.884	24.831	4
For entire sample		85.421	20.768	9

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Variable .. OCU5P1 PERCENT 2ND > 200M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	69.725	13.692	5
CONDITION	M1	27.025	31.839	4
For entire sample		50.747	31.310	9

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Variable .. OCU5P2 PERCENT 2ND > 200M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	57.719	31.466	5
CONDITION	M1	23.165	19.197	4
For entire sample		42.362	31.063	9

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Variable .. OCU7P1 PERCENT 2ND < 100M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	4.840	7.414	5
CONDITION	M1	27.389	18.434	4
For entire sample		14.862	17.209	9

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Variable .. OCU7P2 PERCENT 2ND < 100M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	15.044	25.452	5
CONDITION	M1	24.918	23.582	4
For entire sample		19.432	23.654	9

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.54659	1.20549	4.00	4.00	.430
Hotellings	1.20549	1.20549	4.00	4.00	.430
Wilks	.45341	1.20549	4.00	4.00	.430
Roys	.54659				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.97511	39.17780	4.00	4.00	.002
Hotellings	39.17780	39.17780	4.00	4.00	.002
Wilks	.02489	39.17780	4.00	4.00	.002
Roys	.97511				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .00002
Chi-square approx. = 58.81413 with 9 D. F.
Significance = .000

Greenhouse-Geisser Epsilon = .26038
Huynh-Feldt Epsilon = .30938
Lower-bound Epsilon = .25000

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.38823	.63461	4.00	4.00	.665
Hotellings	.63461	.63461	4.00	4.00	.665
Wilks	.61177	.63461	4.00	4.00	.665
Roys	.38823				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.52996	1.12749	4.00	4.00	.455
Hotellings	1.12749	1.12749	4.00	4.00	.455
Wilks	.47004	1.12749	4.00	4.00	.455
Roys	.52996				

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MANOVA ON OCU3, OCU4, OCU5, OCU7 X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. OCU3P1 CC DIST FROM UNIT COM - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	385.549	209.801	5
CONDITION	M1	344.678	310.468	4
For entire sample		367.384	242.113	9

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Variable .. OCU3P2 CC DIST FROM UNIT COM - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	438.837	298.014	5
CONDITION	M1	737.885	364.183	4
For entire sample		571.748	344.940	9

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Variable .. OCU4P1 PERCENT CO > 600M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	100.000	.000	5
CONDITION	M1	100.000	.000	4
For entire sample		100.000	.000	9

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Variable .. OCU4P2 PERCENT CO > 600M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	66.497	33.070	5
CONDITION	M1	87.589	20.199	4
For entire sample		75.871	28.695	9

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Variable .. OCU5P1 PERCENT 2ND > 200M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	58.425	36.164	5
CONDITION	M1	38.634	41.821	4
For entire sample		49.629	37.664	9

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Variable .. OCU5P2 PERCENT 2ND > 200M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	78.935	31.720	5
CONDITION	M1	45.051	41.617	4
For entire sample		63.875	38.360	9

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Variable .. OCU7P1 PERCENT 2ND < 100M - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	17.407	24.900	5
CONDITION	M1	19.788	31.201	4
For entire sample		18.465	26.013	9

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Variable .. OCU7P2 PERCENT 2ND < 100M - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	5.625	12.578	5
CONDITION	M1	19.514	13.157	4
For entire sample		11.798	14.057	9

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.92529	12.38538	4.00	4.00	.016
Hotellings	12.38538	12.38538	4.00	4.00	.016
Wilks	.07471	12.38538	4.00	4.00	.016
Roys	.92529				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.98898	89.71803	4.00	4.00	.000
Hotellings	89.71803	89.71803	4.00	4.00	.000
Wilks	.01102	89.71803	4.00	4.00	.000
Roys	.98898				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .00002
Chi-square approx. = 59.34595 with 9 D. F.
Significance = .000

Greenhouse-Geisser Epsilon = .25831
Huynh-Feldt Epsilon = .30583
Lower-bound Epsilon = .25000

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.36331	.57063	4.00	4.00	.700
Hotellings	.57063	.57063	4.00	4.00	.700
Wilks	.63669	.57063	4.00	4.00	.700
Roys	.36331				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1 , N = 1)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.67580	2.08452	4.00	4.00	.247
Hotellings	2.08452	2.08452	4.00	4.00	.247
Wilks	.32420	2.08452	4.00	4.00	.247
Roys	.67580				

MANOVA ON UPN1 & UPN5 X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations
Variable .. UPN1P1 DIST TRAVELLED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	20087.148	2378.830	27
CONDIT	M1	24227.536	3764.224	28
For entire sample		22194.982	3764.696	55

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Variable .. UPN1P2 DIST TRAVELLED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	10688.704	1672.794	27
CONDIT	M1	12049.786	1406.589	28
For entire sample		11381.618	1675.740	55

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Variable .. UPN5P1 FUEL USED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	26.651	6.721	27
CONDIT	M1	37.226	9.177	28
For entire sample		32.035	9.608	55

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Variable .. UPN5P2 FUEL USED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	14.665	5.557	27
CONDIT	M1	18.678	5.371	28
For entire sample		16.708	5.779	55

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDIT
Multivariate Tests of Significance (S = 1, M = 0, N = 25)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.30851	11.60018	2.00	52.00	.000
Hotellings	.44616	11.60018	2.00	52.00	.000
Wilks	.69149	11.60018	2.00	52.00	.000
Roys	.30851				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 0, N = 25)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.98539	1753.04110	2.00	52.00	.000
Hotellings	67.42466	1753.04110	2.00	52.00	.000
Wilks	.01461	1753.04110	2.00	52.00	.000
Roys	.98539				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .00001
Chi-square approx. = 598.46811 with 2 D. F.
Significance = .000

Greenhouse-Geisser Epsilon = .50000
Huynh-Feldt Epsilon = .50962
Lower-bound Epsilon = .50000

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EFFECT .. CONDIT BY PHASE
Multivariate Tests of Significance (S = 1, M = 0, N = 25)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.32885	12.73953	2.00	52.00	.000
Hotellings	.48998	12.73953	2.00	52.00	.000
Wilks	.67115	12.73953	2.00	52.00	.000
Roys	.32885				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 0, N = 25)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.95382	537.00856	2.00	52.00	.000
Hotellings	20.65418	537.00856	2.00	52.00	.000
Wilks	.04618	537.00856	2.00	52.00	.000
Roys	.95382				

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MANOVA ON UPN1 & UPN5 X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. UPN1P1 DIST TRAVELLED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	7010.714	1776.632	28
CONDIT	M1	7733.357	4502.528	28
For entire sample		7372.036	3410.942	56

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Variable .. UPN1P2 DIST TRAVELLED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	3482.536	2176.819	28
CONDIT	M1	4912.500	2568.169	28
For entire sample		4197.518	2466.673	56

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Variable .. UPN5P1 FUEL USED - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	12.597	2.692	28
CONDIT	M1	16.263	9.026	28
For entire sample		14.430	6.854	56

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Variable .. UPN5P2 FUEL USED - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDIT	CVC2	7.777	3.296	28
CONDIT	M1	11.843	6.688	28
For entire sample		9.810	5.612	56

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* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

Tests involving Between-Subjects Effects.

EFFECT .. CONDIT
Multivariate Tests of Significance (S = 1, M = 0, N = 25 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.15660	4.92042	2.00	53.00	.011
Hotellings	.18568	4.92042	2.00	53.00	.011
Wilks	.84340	4.92042	2.00	53.00	.011
Roys	.15660				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 0, N = 25 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.91631	290.15274	2.00	53.00	.000
Hotellings	10.94916	290.15274	2.00	53.00	.000
Wilks	.08369	290.15274	2.00	53.00	.000
Roys	.91631				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W -2.173252E-06
Chi-square approx. - 691.08215 with 2 D. F.
Significance - .000

Greenhouse-Geisser Epsilon - .50000
Huynh-Feldt Epsilon - .50943
Lower-bound Epsilon - .50000

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EFFECT .. CONDIT BY PHASE
Multivariate Tests of Significance (S - 1, M - 0, N - 25 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.01739	.46907	2.00	53.00	.628
Hotellings	.01770	.46907	2.00	53.00	.628
Wilks	.98261	.46907	2.00	53.00	.628
Roys	.01739				

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EFFECT .. PHASE
Multivariate Tests of Significance (S - 1, M - 0, N - 25 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.34529	13.97601	2.00	53.00	.000
Hotellings	.52740	13.97601	2.00	53.00	.000
Wilks	.65471	13.97601	2.00	53.00	.000
Roys	.34529				

MANOVA ON TAE1B, TAE2B, TAE4B, X COND X PHASE (RPTD)
OFFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. TAE1BP1 MAX LASE RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	2743.040	400.597	10
CONDITION	M1	3135.832	893.195	6
For entire sample		2890.337	633.080	16

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Variable .. TAE1BP2 MAX LASE RANGE - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	2901.581	787.744	10
CONDITION	M1	2583.493	1184.587	6
For entire sample		2782.298	930.252	16

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Variable .. TAE2BP1 MEDIAN HIT RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	972.405	498.699	10
CONDITION	M1	931.500	620.067	6
For entire sample		957.065	527.067	16

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Variable .. TAE2BP2 MEDIAN HIT RANGE - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1029.211	592.587	10
CONDITION	M1	711.371	488.963	6
For entire sample		910.021	561.824	16

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Variable .. TAE4BP1 MEDIAN KILL RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	853.251	461.592	10
CONDITION	M1	599.810	469.655	6
For entire sample		758.211	466.287	16

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1012.670	600.181	10
CONDITION	M1	695.114	450.971	6
For entire sample		893.587	555.996	16

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Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1/2, N = 5)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.16785	.80685	3.00	12.00	.514
Hotellings	.20171	.80685	3.00	12.00	.514
Wilks	.83215	.80685	3.00	12.00	.514
Roys	.16785				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1/2, N = 5)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.96224	101.93481	3.00	12.00	.000
Hotellings	25.48370	101.93481	3.00	12.00	.000
Wilks	.03776	101.93481	3.00	12.00	.000
Roys	.96224				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .23931
Chi-square approx. = 18.19293 with 5 D. F.
Significance = .003

Greenhouse-Geisser Epsilon = .71064
Huynh-Feldt Epsilon = .90187
Lower-bound Epsilon = .33333

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 5)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.24422	1.29257	3.00	12.00	.322
Hotellings	.32314	1.29257	3.00	12.00	.322
Wilks	.75578	1.29257	3.00	12.00	.322
Roys	.24422				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 5)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.31655	1.85263	3.00	12.00	.191
Hotellings	.46316	1.85263	3.00	12.00	.191
Wilks	.68345	1.85263	3.00	12.00	.191
Roys	.31655				

MANOVA ON TAE1B, TAE2B, TAE4B, X COND X PHASE (RPTD)
DEFENSIVE SCENARIO

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Cell Means and Standard Deviations

Variable .. TAE1BP1 MAX LASE RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	3384.856	474.195	17
CONDITION	M1	3138.411	644.494	12
For entire sample		3282.879	554.015	29

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Variable .. TAE1BP2 MAX LASE RANGE - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	2993.884	443.760	17
CONDITION	M1	2789.093	855.505	12
For entire sample		2909.142	640.774	29

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Variable .. TAE2BP1 MEDIAN HIT RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1750.480	460.233	17
CONDITION	M1	1358.002	387.829	12
For entire sample		1588.076	467.789	29

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Variable .. TAE2BP2 MEDIAN HIT RANGE - P2

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1703.007	360.382	17
CONDITION	M1	1419.363	542.737	12
For entire sample		1585.637	458.419	29

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Variable .. TAE4BP1 MEDIAN KILL RANGE - P1

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1861.921	433.903	17
CONDITION	M1	1364.710	478.207	12
For entire sample		1656.179	509.443	29

* * ANALYSIS OF VARIANCE -- DESIGN 1 * *

FACTOR	CODE	Mean	Std. Dev.	N
CONDITION	CVC2	1810.266	513.429	17
CONDITION	M1	1222.712	437.407	12
For entire sample		1567.140	559.042	29

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Tests involving Between-Subjects Effects.

EFFECT .. CONDITION
Multivariate Tests of Significance (S = 1, M = 1/2, N = 11 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.37030	4.90045	3.00	25.00	.008
Hotellings	.58805	4.90045	3.00	25.00	.008
Wilks	.62970	4.90045	3.00	25.00	.008
Roys	.37030				

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EFFECT .. CONSTANT
Multivariate Tests of Significance (S = 1, M = 1/2, N = 11 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.98092	428.37877	3.00	25.00	.000
Hotellings	51.40545	428.37877	3.00	25.00	.000
Wilks	.01908	428.37877	3.00	25.00	.000
Roys	.98092				

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Tests involving 'PHASE' Within-Subject Effect.

Mauchly sphericity test, W = .61265
Chi-square approx. = 12.60282 with 5 D. F.
Significance = .027

Greenhouse-Geisser Epsilon = .78210
Huynh-Feldt Epsilon = .89294
Lower-bound Epsilon = .33333

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EFFECT .. CONDITION BY PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 11 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.04240	.36902	3.00	25.00	.776
Hotellings	.04428	.36902	3.00	25.00	.776
Wilks	.95760	.36902	3.00	25.00	.776
Roys	.04240				

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EFFECT .. PHASE
Multivariate Tests of Significance (S = 1, M = 1/2, N = 11 1/2)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Pillais	.34449	4.37940	3.00	25.00	.013
Hotellings	.52553	4.37940	3.00	25.00	.013
Wilks	.65551	4.37940	3.00	25.00	.013
Roys	.34449				

Appendix F

Biographical Data Tables

BIOGRAPHICAL DATA TABLES

To profile the demographic characteristics of each group of participants, key factors from the Biographical questionnaire were analyzed. These factors included age, military rank, civilian education level, armor experience, M1 tank experience, time assigned to combat maneuver (TO&E) units, SIMNET experience, and level of computer experience. Student's t-test and the chi square test for independent samples (Siegel, 1956) were used to determine the statistical significance of group differences. Because one gunner and one driver participated in both the CVCC and IVCC conditions, the number of CVCC participants reported in these analyses totals only 103.

Among the CVCC participants, ages ranged from 18-41, with a mean of 24.5 years (standard deviation, or SD, 5.2). Ages of the M1 Baseline participants ranged from 18-40, with a mean of 25.6 years (SD, 5.6). The difference between these means was not significant (t = 1.45, df = 185, p = .15). Table F-1 presents the distribution of ages for each condition. Considering only vehicle commanders, ages averaged 27.8 years (SD, 5.0) for the CVCC condition and 28.1 years (SD, 4.4) for the M1 Baseline condition. The mean difference for this subset was not significant (t = .25, df = 61, p = .80).

Table F-1

Age Distributions of Participants, by Condition

Age (in years)	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
18-20	26	25.2	18	21.4
21-23	23	22.3	20	23.8
24-26	25	24.3	14	16.7
27-29	12	11.7	9	10.7
30-32	6	5.8	10	11.9
33-35	7	6.8	8	9.5
>35	4	3.9	5	6.0
Mean:	24.5 yrs		25.6 yrs	

The distribution of participants among the various military ranks was quite similar for the two conditions. Table F-2 breaks out the numbers in each rank, along with the corresponding percentages of the total sample. Among vehicle commanders, the distributions did not differ significantly ($X^2 = 6.56$, $df = 5$, $p > .20$).

Table F-2

Rank Distributions of Participants, by Condition

Rank	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
Vehicle Commanders				
Captain	2	1.9	1	1.2
First Lieutenant	7	6.8	6	7.1
Second Lieutenant	11	10.7	9	10.7
Sergeant First Class	4	3.9	0	0
Staff Sergeant	9	8.7	12	14.3
Sergeant	2	1.9	0	0
Gunners/Drivers				
Staff Sergeant	0	0	3	3.6
Sergeant	7	6.8	14	16.7
Corporal/Specialist	27	26.2	12	14.3
Private First Class	19	18.4	13	15.5
Private	15	14.6	14	16.7

Table F-3 characterizes the two groups in terms of level of education. While the two samples were distributed quite similarly among the various education levels, somewhat more of the M1 Baseline participants had completed at least some college than was true for the CVCC participants. Those holding at least a baccalaureate degree were nearly identical for the two groups: 23.3 percent for the CVCC participants, compared with 21.4 percent for the M1 Baseline participants. The distributions for the two groups did not differ significantly ($X^2 = 2.82$, $df = 3$, $p > .30$).

Table F-3

Education Levels of Participants, by Condition

Education Level	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
High School/GED	52	50.5	36	42.9
Some College	27	26.2	30	35.7
Baccalaureate Degree	19	18.4	16	19.0
Postgraduate	5	4.9	2	2.4

Among the participants in the CVCC condition, total time in armor (including cavalry) ranged from 0 to 223 months, with a mean of 49.9 months (SD, 52.3). Time in armor for the M1 Baseline participants ranged from 5 to 210 months, with a mean of 55.8 months (SD, 52.6). The difference between these means was not significant (t = .77, df = 185, p = .44). Table F-4 displays the distributions of participants across time intervals for both conditions. Considering only vehicle commanders, mean time in armor for the CVCC group was 69.8 months (SD, 66.7), compared with a mean of 73.4 months (SD, 63.6) for the M1 Baseline group. These group means did not differ significantly (t = .22, df = 61, p = .83).

Table F-4

Participants' Experience in Armor, by Condition

Time (in months)	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
0-6	12	11.7	5	6.0
6.1-12	16	15.5	14	16.7
12.1-24	20	19.4	18	21.4
24.1-60	29	28.2	21	25.0
60.1-120	13	12.6	13	15.5
>120	13	12.6	13	15.5
Mean:	49.9 mos		55.8 mos	

Reported cumulative experience with the M1 tank ranged from 0 to 108 months for the CVCC participants, the mean being 15.1 months (SD, 21.9). M1 experience for participants in the M1 Baseline ranged from 0 to 84 months, with a mean of 13.1 months (SD, 16.7). These means did not differ significantly (t = .68, df = 185, p = .50). The distributions of participants for this parameter appear in Table F-5. Looking at vehicle commanders only, M1 experience averaged 17.3 months (SD, 25.3) in the CVCC condition, while the M1 Baseline mean was 19.3 months (SD, 22.6). These subset means did not differ significantly (t = .32, df = 61, p = .75).

Table F-5

Participants' Experience on the M1 Tank, by Condition

Time (in months)	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
0-6	48	46.6	39	46.4
6.1-12	14	13.6	10	11.9
12.1-24	24	23.3	25	29.8
24.1-60	11	10.7	7	8.3
>60	6	5.8	3	3.6
Mean:	15.1 mos		13.1 mos	

Experience in TO&E units was considered potentially important because the wartime mission of such units normally dictates rigorous field training. Reported TO&E experience ranged from 0 to 16 years for CVCC participants, averaging 2.9 years (SD, 3.9). For M1 Baseline participants, this parameter ranged from 0 to 16 years also, with a mean of 3.4 years (SD, 4.0). The difference between the two conditions was not significant (t = .83, df = 185, p = .41). The distributions seen in Table F-6 indicate great similarity between the two conditions. Among vehicle commanders only, TO&E experience averaged 4.2 years (SD, 4.5) in the CVCC condition, compared to a mean of 4.7 years (SD, 4.3) in the M1 Baseline condition. The mean difference for the vehicle commanders was not significant (t = .39, df = 61, p = .70).

Table F-6

Participants' Experience in TO&E Units, by Condition

Time (in years)	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
<1	41	39.8	26	31.0
1-3	28	27.2	25	29.8
3.1-6	16	15.5	15	17.9
6.1-12	13	12.6	15	17.9
>12	5	4.9	3	3.6
Mean:	2.9 yrs		3.4 yrs	

Among the CVCC participants, reported hours in SIMNET (Table F-7) ranged from 0 to 1920, with a mean of 57.1 hours (SD, 107.3). The range among M1 Baseline participants was 0 to 300 hours, the mean being 30.8 (SD, 55.8). The means for the two conditions did not differ significantly (t = 1.80, df = 185, p = .07). Considering only vehicle commanders, the mean for the CVCC condition was 46.0 hours (SD, 50.1), compared to 41.8 hours (SD, 57.1) for M1 Baseline vehicle commanders. The mean difference separating the two subsets was not significant (t = .31, df = 61, p = .76).

Table F-7

Participants' Experience in SIMNET, by Condition

Time (in hours)	CVCC Number	CVCC Percent	M1 Baseline Number	M1 Baseline Percent
0-8	23	22.3	47	56.0
9-40	40	38.8	22	26.2
41-80	18	17.5	6	7.1
81-200	19	18.4	7	8.3
>200	3	2.9	2	2.4
Mean:	57.1 hrs		30.8 hrs	

Due to the computer-based nature of the automated equipment, participants' experience with computers was considered an important factor. Table F-8 summarizes the distributions of participants in terms of self-reported computer experience. The distributions for the two groups did not differ significantly (X^2 = 2.12, $\underline{df}$ = 3, $\underline{p}$ > .50). Because of the ordinal nature of the scale used in the questionnaire, no means and standard deviations were computed for this parameter.

Table F-8

Participants' Experience with Computers, by Condition

Experience	CVCC		M1 Baseline	
	Number	Percent	Number	Percent
None	15	14.6	12	14.3
Limited	45	43.7	32	38.1
Moderate	33	32.0	26	31.0
Considerable	10	9.7	14	16.7

Appendix G

Acronym List

CVCC EVALUATION
ACRONYM LIST

ACRONYM	DEFINITION
AA	Assembly Area
AAR	After Action Review
ACOR	Assistant Contracting Officer's Representative
ACR	Armored Cavalry Regiment
ADA	Air Defense Artillery
ADW	Air Defense Warning
ANOVA	Analysis of Variance
AOR	Area of Responsibility
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ARTEP	Army Training and Evaluation Program
ASAP	As Soon As Possible
ASCII	American Standard Code for Information Interchange
ASVAB	Armed Services Vocational Aptitute Battery
BBN	Bolt Beranek & Newman Inc.
BDM	BDM International, Inc.
BFV	Bradley Fighting Vehicle
BHO	Battle Hand Off
BHOT	Black Hot
BHOL	Battle Hand Off Line
BIS	Battlefield Information System
BLUFOR	Blue Forces
BMS	Battlefield Management System
BOS	Battlefield Operating System
BP	Battle Position
B\P	Be Prepared
BSA	Brigade Support Area
CAA	Combined Arms Army
C^2	Command and Control
C^3	Command, Control and Communication
C^3IEW	Command, Control, Communications, Intelligence, and Electronic Warfare
Co Cdr	Company Commander
CCD	Command and Control Display
CCTB	Close Combat Test Bed
CEOI	Communications and Electronics Operating Instructions
CFF	Call for Fire
CFL	Control Fire Line
CID	Commander's Integrated Display
CITV	Commander's Independent Thermal Viewer
CoM	Center of Mass
COR	Contracting Officer's Representative
CP	Checkpoint
CRT	Cathode Ray Tube
CS	Combat Support
CSS	Combat Service Support
CVCC	Combat Vehicle Command and Control

DCA	Data Collection & Analysis System
DCD	Directorate of Combat Developments
df	Degrees of Freedom
DL	DataLogger
DTG	Date-Time-Group
ECR	Exercise Control Room
ENDEX	End of Exercise
ETT	End of Transmission Time
FA	Field Artillery
FAADS	Forward Area Air Defense System
FASCAM	Family of Scatterable Mines
FPF	Final Protective Fires
FRAGO	Fragmentary Order
FSB	Forward Support Battalion
FSO	Fire Support Officer
FST-1	Future Soviet Tank-1
GARB	Green, Amber, Red, Black
GLOS	Gun Line of Sight
GMRD	Guards Motorized Rifle Division
GPS	Gunner's Primary Sight
GPSE	Gunner's Primary Sight Extension
GTD	Guards Tank Division
HE/VT	High Explosive/Variable Time
ID (M)	Infantry Division (Mechanized)
INTELREP	Intelligence Report
INTSUM	Intelligence Summary
IVCC	Intravehicular Command and Control
IVIS	Intervehicular Information System
JRTC	Joint Readiness Training Center
LD	Line of Departure
LOA	Limit of Advance
LOS	Line of Sight
LRF	Laser Range Finder
LTC	Lieutenant Colonel
M, C/M, S	Mobility, Counter-Mobility, and Survivability
MANOVA	Multivariate Analysis of Variance
MCC	Management, Command and Control System
METT-T	Mission, Enemy, Troops, Terrain-Time Available
MOPP	Mission Oriented Protective Posture
MOS	Military Occupational Specialty
MRB	Motorized Rifle Battalion
MRC	Motorized Rifle Company
MRP	Motorized Rifle Platoon
MRR	Motorized Rifle Regiment
MTC	Movement to Contact
NBC	Nuclear, Biological, Chemical
NCO	Non-Commissioned Officer
NCS	No Change in Status
NETT	New Equipment Training Team
NLT	Not Later Than
NTC	National Training Center

OEG	Operational Exposure Guide
O/O	On Order
OP	Observation Post
OPFOR	Opposing Forces
OPORD	Operations Order
PIR	Priority Intelligence Requirements
PL	Phase Line
Plt Ldr	Platoon Leader
PoE	Priority of Effort
PoM	Priority of Mission
POSNAV	Position Navigation
POSNAV-G	Position Navigation-Grid
POSNAV-T	Position Navigation-Terrain
PP	Passage Point
PLT SGT.	Platoon Sergeant
PVD	Plan View Display
PW	Platoon Leader's Wingman
QC	Quality Control
R & D	Research and Development
RA	Research Assistant
REDCON	Readiness Condition
RJ	Road Junction
RWA	Rotary Wing Aircraft
RP	Release Point
RPoL	Rearward Passage of Lines
S3	Operations Staff Officer
SA	Situational Awareness
SACCD	Stand-Alone CCD
SAFOR	Semiautomated Forces
SCC	SIMNET Control Console
SIM	Simulator
SIMNET	Simulation Network
SIMNET-D	Simulation Network--Developmental
SIMNET-T	Simulation Network--Training
SINCGARS	Single Channel Ground Airborne Radio System
SITREP	Situation Report
SME	Subject Matter Expert
SMI	Solder-Machine Interface
SOI	Signal Operating Instructions
SOP	Standard Operating Procedure
SP	Start Point
SPOTREP	Spot Report
SPSS	Statistical Package for the Social Sciences
SSI	Specialty Skill Identifier
SW	Platoon Sergeant's Wingman
TAF	Tactical Air Force
TC	Tank Commander
TF	Task Force
TO&E	Table of Organization & Equipment
TOC	Tactical Operations Center
TR	Tank Regiment
TRADOC	U.S. Army Training and Doctrine Command

CVCC EVALUATION
ACRONYM LIST (Cont'd.)

TRP	Target Reference Point
UCOFT	Unit Conduct of Fire Trainer
USAARMC	U.S. Army Armor Center
UTM	Universal Transverse Mercator
WCS	Weapon Control Status
WHOT	White Hot
XO	Executive Officer